Telopea 12(1) 71–118

The genus *Cycas* (Cycadaceae) in China

K.D. Hill

National Herbarium of New South Wales, Royal Botanic Gardens, Mrs Macquaries Road, Sydney 2000, Australia

Abstract

The genus *Cycas* is reviewed within China. Twenty two species are enumerated, one with two subspecies, and the species are placed within an infrageneric classification previously outlined. *C. panzhihuaensis* is placed in the new Section ***Panzhihuaenses***. Lectotypes are designated for *Cycas revoluta*, *C. balansae* and *C. miquelii*. Distribution of all taxa is mapped, conservation status discussed and a key to species provided.

Introduction

The genus *Cycas* is the single constituent genus of the family Cycadaceae, itself the basal lineage of the living cycads or Cycadophyta (Stevenson 1992). It is also the sole living cycad group occurring in Asia. The only known fossil evidence for this genus is from the Eocene of China and Japan, and this, together with the occurrence of all major lineages in the genus in mainland Asia, supports a long-term presence and probable origin of this genus in that region (Hill 1995). *Cycas* consists of about 100 species, chiefly Indo-Chinese (about 40 species) and Australian (27 species). The genus also occurs in the Malesian region, Japan and India, extending to Micronesia and Polynesia, Madagascar and East Africa. Plants are commonly understorey shrubs in forest, woodland or savanna habitats. Twenty two species are known in China.

The present work is the outcome of ongoing studies, with a total of three field trips during the period 1996–2000. Herbarium collections held by A, B, BM, BO, E, HN, K, KNF, KUN, G, L, LAE, LE, NY, PE, P and U have been examined. All specimens cited have been examined except where stated. Terminology is as in previous papers in this series (e.g. Hill 1994), as are generic and specific concepts applied. Conventions in measurements taken and presented in the following descriptions are as in other papers in this series, and are set out in Lindstrom and Hill (2007). Nomenclature follows the latest version of the International Code of Botanical Nomenclature [ICBN] (McNeill et al. 2006).

Taxonomic History

The cycad flora of China has not been well understood in the past, as is evidenced by the history of species description. Only four of the 22 species recognised herein were described before 1975, with only one of these actually being described from Chinese material.

 ISSN0312-9764

The comprehensive account of the genus by de Candolle (1868) summarised work to that point, and recorded no cycad species from the region of China. Pilger (1926) recorded only *C. revoluta* and *C. taiwaniana* from China. Schuster (1932) recorded *C. siamensis* (based on *Morse 273*), *C. micholitzii* (also based on *Morse 273*) and *C. revoluta* (which included *C. taiwaniana* as a variety) as Chinese, but clearly showed little understanding of the taxonomy or geography of the species.

Cheng et al. (1975) enumerated 8 species, 7 of which they regarded as native in China. They misapplied the name *C. siamensis* to the species here treated as *C. collina*, and also confused the concept of *C. taiwainiana*, including citations of *C. taitungensis* under what was essentially the correct description for *C. taiwaniana*.

Since 1975, some 32 new species names have been coined for cycads occurring naturally in China. Many of these are herein regarded as superfluous names falling into synonymies of other species, and are listed below under the species concerned. No recent publication has fully correctly applied the available names for the Chinese cycads (Chen & Stevenson 1999, Chen & Liu 2004, Xaio et al. 2004, Xaio & Gong 2006) and this publication was seen as necessary in order to clarify nomenclatural applications in China.

Hybridism

The problem of hybridism in *Cycas* has been introduced elsewhere (Hill 1992, 1996). The lack of pollinator specificity, when combined with the apparently weak inherent fertility barriers, results in the major reproductive barrier between *Cycas* species in nature being geographic separation. Natural populations of *Cycas* species are usually widely separated geographically, and some breakdown of reproductive isolation would therefore be expected where different species have spread to within pollination range of each other.

A number of natural occurrences are postulated to be of just such hybrid origin. These are morphologically intermediate between the putative parent species and, in the cases of postulated hybrid swarms, show the high degree of variability to be expected from Mendelian segregation in second and later generations. Hybrids and hybrid or intergrading populations have been recorded from throughout the range of *Cycas*, wherever different species grow in relatively close proximity. Examples from China include intergradation between *C. bifida* and *C. multipinnata* and between *C. bifida* and *C. dolichophylla* (cited below under the first species of the pair listed). Plants in cultivation at Shenzhen Fairy Lake Botanic Garden are thought to represent hybrids between *C. bifida* and *C. diannanensis* [no voucher].

Conservation

Populations of many Asian species appear to have declined, sometimes dramatically, over the past century. However, there is no comparative data to support this impression, and evidence for the decline is largely anecdotal and circumstantial. Several causative factors for this decline can be observed in action today, however, even though quantitative data on the effects are not available. Two principal threats to cycads exist in China at present, habitat loss and selective removal of plants from the wild for trade or utilisation. Some

but not all species occur in reserved areas already proclaimed, but enforcement within these areas is sometimes difficult. There is, however, a growing interest in habitat and species conservation within China, and additional reserved areas are being evaluated and declared.

Conservation status of all Chinese species is summarised in Table 1.

Taxonomic treatment

CYCAS L., Sp. Pl.: 1188 (1753). Lectotype: *C. circinalis* L.; designated by Stevenson in Jarvis et al. (1993).

Dioecious palm-like shrubs with aerial or subterranean, pachycaul, cylindrical stems clad with persistent leaf-bases. Leaves loosely pubescent when young, pinnate, spirally arranged, produced in seasonal growth flushes interspersed with cataphylls, lower leaflets often reduced to spines. Longitudinal ptyxis erect or rarely reflexed, horizontal ptyxis circinate. Leaflets with a single thick midrib and no lateral veins; stomata confined to abaxial surface in most species; individual ptyxis involute. Trichomes microscopically transparent, branched or simple. Leaves with vascular traces girdling stems, girdling traces not present in cataphylls or megasporophlls. Microsporophylls aggregated into determinate cones and bearing numerous microsporangia (pollen-sacs) on abaxial surfaces, with a simple sterile apex, which is often produced into an upturned spine; microsporangia opening by slits; pollen cymbiform, monosulcate. Seed cones closed at pollination, closed at seed set (in all Chinese species). Megasporophylls spirally arranged in an indeterminate terminal rosette with the central axis continuing vegetative growth. Ovules two to many (rarely one), marginally inserted on the stipe and directed obliquely outwards ('ascending'); sporophyll apically dilated into a pinnatifid, pectinate, toothed or entire lamina. Seeds with a yellow, orange or brown fleshy outer sarcotesta, and with or without spongy tissue beneath the inner woody sclerotesta. Endosperm haploid, derived from the female gametophyte. Embryo straight; with 2 cotyledons that are usually united at the tips and a very long, spirally twisted suspensor; seeds platyspermic; germination cryptocotylar.

About 100 species, chiefly Australian (27 species) and Indo-Chinese (about 40 species). The genus also occurs in the Malesian region, Japan and India, extending to Micronesia and Polynesia, Madagascar and East Africa. Plants are commonly understorey shrubs in forest, woodland or savanna habitats. Six sections are now recognised; four in Hill (1995), another in Lindstrom et al. (2008) and an additional one in this paper. There has been disagreement on subgeneric division (Wang 1996, de Laubenfels 1998) and, in the light of improved understanding of the genus, none of the proposed systems would appear entirely adequate (Hill 1998, Hill 2004a, Hill 2004b) Four clear groups, regarded below as sections, occur naturally in China.

Key to sections occurring in China

1 Ovules tomentose ..... Section *Asiorientales*

1* Ovules glabrous

2 Microsporangiate sporophylls soft or waxy, lacking an apical spine or with a very slender tightly appressed apiculus

3 Microsporangiate sporophylls waxy; seeds red or orange; stomata encrypted ..... Section *Panzhihuaenses*

3* Microsporangiate sporophylls soft; seeds yellow; stomata not encrypted..... Section *Stangerioides*

2* Microsporangiate sporophylls hard, with a distinct apical spine

4 Megasporophyll pectinate ..... Section *Indosinenses*

4* Megasporophyll entire or dentate, not deeply pectinate ..... Section #*Cycas*

#Not known naturally in China, present in India, Thailand and Vietnam, not treated further in this paper

Key to species in China

1 Leaflets simple

2 Leaves distinctly keeled (opposing leaflets inserted at less than 150° on rachis)

3 Trunk not tomentose at apex; trunk smooth; mature leaves grey-green ..... 22. *C. hongheensis*

3* Trunk densely tomentose at apex; trunk not smooth; mature leaves dark green

4 Leaflets with margins revolute ..... 1. *C. revoluta*

4* Leaflets with margins recurved, never revolute ..... 2. *C. taitungensis*

2* Leaves flat or openly keeled (opposing leaflets inserted at more than 150° on rachis)

5 Microsporangiate cones soft or waxy; sarcotesta not fibrous; sclerotesta with more or less verrucose ornamentation

6 Apical spine of megasporophyll lamina dilated, markedly different from lateral spines

7 Plants lithophytic on exposed limestone outcrops

8 Megasporophyll lamina 35–55 long × 30–50 mm wide ...20. *C. sexseminifera*

8* Megasporophyll lamina 70–110 long × 50–80 mm wide... 19. *C. ferruginea*

7* Plants growing in soil

9 Trunks subterranean

10 Leaflets 6–10 mm wide, twisted on rachis ..... 15. *C. changjiangensis*

10* Leaflets 9–20 mm wide, flat on rachis ..... 5. *C. segmentifida*

9* Trunks aerial

11 Male cones 50 cm long or more ..... 7. *C. diannanensis*

11* Male cones less than 50 cm long

12 Sarcostesta red or orange ..... 3. *C. panzhihuaensis*

12* Sarcostesta yellow

13 Petioles spinescent throughout, including across swollen petiole base

14 Leaflets 9–16 mm wide; petiole 30–60% of leaf; trunk not swollen at base ..... 12. *C. taiwaniana*

14* Leaflets 6–10 mm wide; petiole 20–30% of leaf; trunk swollen at base ..... 13. *C. hainanensis*

13* Petioles usually not spinescent throughout, especially not across swollen petiole base

15 Leaflets 8–12 mm wide, twisted on rachis .. 4. *C. guizhouensis*

15* Leaflets 9–20 mm wide, flat on rachis ..... 5. *C. segmentifida*

6* Apical spine of megasporophyll lamina not dilated, similar to lateral spines

16 Microsporophyll with a distinct terminal spine.....10. *C. tanqingii*

16* Microsporophyll lacking a terminal spine

17 Petiolar spines 4–10 mm long

18 Leaflets 10–15 mm wide, narrowed and tapered at base, petiole long (30–40% of leaf) ..... 9. *C. balansae*

18* petiole short (20–35% of leaf) ..... 6. *C. dolichophylla*

17* Petiolar spines 1–3 mm long

19 Plant arborescent

20 Petiole length greater than or equal to 50 cm ..... 11. *C. szechuanensis*

20* Petiole length less than 50 cm ..... 14. *C. shanyaensis*

19* Plant acaulescent ..... 8. *C. collina*

5* Microsporangiate cones firm; sarcotesta with a fibrous layer; sclerotesa not ornamented ..... 21. *C. pectinata*

1* Leaflets divided

21 Leaflets themselves pinnately divided

22 Leaves 1–2, to 6 m, segments obovate-linear, apex shortly acuminate to caudate..... 17. *C. multipinnata*

22* Leaves 3–15, to 3.0 m, segments linear, apex long attenuate or long acuminate ..... 18. *C. debaoensis*

21* Leaflets dichotomously divided only ..... 16. *C. bifida*

Table 1. Conservation status of Chinese cycads.

	Outside China	1997 Red List Status	Reserve	IUCN Ver 3.1 2001 (Donaldson 2003)	Pop. Size	Present Decline	Range (km^2)	Hab. Reduct. (%)
C. balansae	Vietnam	-	y	NT	>10,000	low	400	<30
C. bifida	Vietnam	E*	y	VU	>10,000	high	100	30-50
C. changjiangensis	-	-	y	EN	2000	low	20	50
C. collina	Vietnam		n	VU	2,500 -10,000	low	200	30-50
C. debaoensis	-	-	y	CR	500	high	3	50
C. diannanensis	-	-	n	VU	5000	high	300	50
C. dolichophylla	Vietnam	-	y	VU	>10,000	low	500	30-50
C. ferruginea	Vietnam	-	y	NT	>100,000	low	150	20
C. guizhouensis	-	V	y	NT	>10,000	high	500	20-50
C. hainanensis	-	V		EN	10,000	low	200	50
C. hongheensis	-	E	n	CR	100	high	5	50
C. multipinnata	Vietnam	E	y	EN	1000-2500	low	250	50
C. panzhihuaensis	-	-	y	NT	> 200,000	high	150	20-50
C. pectinata	Cambodia India Laos Nepal Thailand Vietnam	-	y	VU	> 200,000	low	3,000	30-50
C. revoluta	Japan	-	y	NT	>10,000	stable	1000	<20
C. shanyaensis		-	?	NE#	?	?	?	?
C. segmentifida	?Vietnam	-	y	VU	>10,000	low	500	30-50
C. sexseminifera	Vietnam	-	n	NT	>10,000	low	500	<20
C. szechuanensis	-	Ex	n	CR	<100	high	1	?
C. taitungensis	-	V	y	VU	10,000	low	50	30-50
C. taiwaniana	-	V	y	EN	5,000	high	400	50-80
C. tanqingii	?Vietnam	-	n	NT	>100,000	stable	100	<20

*as *C. micholitzii*

recommended status

A. Section **ASIORIENTALES** J. Schust.

Cycas section *Asiorientales* J. Schust., Pflanzenr. 99: 65 (1932).

Type: C. revoluta Thunb.

This section is defined by the firm, waxy microsporangiate cones and microsporophylls, the pectinate megasporophyll apices, the tomentose ovules, and the red seeds with a non-fibrous sarcotesta and a smooth, longitudinally grooved sclerotesta. The group is relictual, and includes only two closely related species occuring in eastern China and southern Japan (Fig. 1). Although firm and waxy as they develop, male cones and microsporophylls become soft and break down quickly afer maturity. This section shares deeply encrypted stomata with section Panzhihuaenses.

1. ***Cycas revoluta*** Thunb., Verh. Holl. Maatsch. Weetensch. Haarlem 20(2): 424, 426–427 (1782).

Type: (lectotype here designated) ex herb. Thunberg (UPS 23734).

Cycas miquelii Warb., Monsunia 1: 179, 181 (1900).

Epicycas miquelii (Warb.) de Laub., in De Laub. & Adema, Blumea 43: 393 (1998).

Lectotype (**here designated**): ex horto Buitenzorg (ex China & Japonic.) in H. Amstelod. introducta (U: two sheets U028127, U028129). See discussion below.

Cycas revoluta var. *brevifrons* Miq., Tijdschr. Wis-Natuurk. Wetensch. Eerste Kl. Kon. Ned. Inst. Wetensch. 1: 207 (1848).

Type: from living garden material, apparently not preserved. This and the varieties listed below apparently represent horticultural variations within *C. revoluta*, of no real taxonomic significance. They are hence included in the synonymy of this species.

Cycas revoluta var. *planifolia* Miq., Monogr. Cycad.: 25–26 (1842).

Type: Hort. Amsterdam, 1840, *Miquel s.n.* (holo U).

Cycas revoluta var. *prolifera* Siebold & Zucc., Abh. Math.-Physik. Cl. Konigl. Bayer. Akad. Wiss. 14(3): 236 (1846).

Type: from living garden material, apparently not preserved.

Cycas revoluta var. *robusta* Messeri, Nuovo Giorn. Bot. Ital., n.s., 34: 324, 327 (1927).

Type: from living garden material cultivated in Florence, apparently not preserved

Literature: Gaudichaud (1829), Merrill (1912), Merrill (1917), Merrill (1923), Leandri (1931), Ho and Duong (1960), Raizada & Sahni (1960), Smitinand (1971), Smitinand (1972), Walker (1976), Zamora and Co (1986), Wang (1996).

Illustrations: Smith (1801), Bot. Mag. (1830), Miquel (1842), Warburg (1900), Schuster (1932), Smitinand (1971), Cheng et al. (1976), Zamora and Co (1986), Wang (1996).

Etymology: from the Latin *revolutus*, rolled, from the rolled leaf margins.

Vernacular: Chinese - *tieshu* (iron tree), *feug-wei-jiao-ye* (phoenix tail banana), *su-tie*, English (hort.) - *sago palm, king sago*; Japanese (Main islands) - *sotetsu* (preferred) (coming back from the dead by iron), *hou bi* (bird's tail feathers), *hou bi shou* (broken banana leaf), *sha ka shou* (firebreak banana), *ban shou* (barbarian's banana), *tesshou, tessio* (iron banana), *tosso*; Japanese (Ryukyu Is) *hichichi, hitichi, satetsu, shichichi, sichi,*

sichidzi, sidzichi, sidzidzui, sihittu, sirichi, sitechi, sitichi, sitidzi, sitochi, sitsuchi, sitsudzu, situchi, suidzu, suchichi, susitykuki, sutachi, suticha, sutichi, sutta, sutuku, suutichi, syutta, syutto, tsudzu (all ref. to whole plants), *kyungama, mii, nadzu, nari, sutitsi-uari, yanabu* (ref. to seeds only) (Osborne & Tomiyama 1995, Bonta & Osborne 2007).

Stems arborescent, to 1–3(–7) m tall, 20 cm diam. at narrowest point, 110–160 leaves in crown. *Leaves* deep green, semiglossy, 50–150 cm long, strongly to moderately keeled (opposing leaflets inserted at 70–120° on rachis), with 100–240 leaflets, with orange tomentum shedding as leaf expands; rachis usually terminated by a spine; petiole 6–10 cm long, (8–15% of total leaf), glabrous, spinescent for 80–100% of length; basal leaflets gradually reducing to spines, 10–20 mm long, spines 1–3 mm long. *Median leaflets* simple, strongly discolorous, 80–180 mm long, 3–6 mm wide, inserted at 30–40° to rachis, decurrent for 2–5 mm; narrowed to 2–3 mm at base (to 33–50% of maximum width), 2.5–5 mm apart on rachis; section slightly keeled; margins revolute; apex aristate, spinescent; midrib flat above, raised below. *Cataphylls* linear, pungent, densely floccose, 7–11 mm long. *Pollen cones* fusiform, yellow, 30–60 cm long, 8–16 cm diam.; microsporophyll lamina waxy, not dorsiventrally thickened, 23–28 mm long, 5.5–10 mm wide, fertile zone 24–27 mm long, sterile apex 6–8 mm long, apical spine absent; apex deflexed, 4.5–8 mm long. *Megasporophylls* 12–19 cm long, yellow-tomentose; ovules 2–6, pubescent; lamina orbicular, 50–120 mm long, 40–55 mm wide, deeply pectinate, with 13–27 soft lateral spines 20–28 mm long, 2–3 mm wide; apical spine distinct or not distinct from lateral spines, 30–50 mm long. *Seeds* ovoid, 25 mm long, 20 mm wide; sarcotesta red, slightly pruinose, 3–5 mm thick; fibrous layer absent; sclerotesta smooth, or longitudinally grooved; spongy endocarp absent.

Historical notes: *C. revoluta* was the second species of *Cycas* to be recognised, described in 1782 by Swedish botanist and physician Carl Peter Thunberg. No type was cited. The 'Tessio' of both Kaempfer (1712: V, 897) and Rumphius (1741: I,70, t.24) were included as synonyms (Thunberg 1784). Reference was also made to cultivated plants, which were probably collected by Thunberg in Japan in 1775–1776, specimens now in UPS. Of the three sheets of *C. revoluta* present in the Thunberg herbarium, the sheet indicated was chosen as lectotype because it was the only sheet annotated 'e Japonia'.

No type was cited by Warburg when he described *C. miquelii*, and distribution was cited only as "Süd-China". However, Warburg (p. 179) makes indirect reference to Miquel's mention of a plant cultivated in the Amsterdam Botanic Garden that had been brought in from the Bogor Botanic Garden and said to be from South China (Miquel 1851: 28); Miquel had incorrectly determined and illustrated these as *C. inermis*. Although not explicitly cited, these would appear to be the basis for *C. miquelii*, and hence can be considered original material under the Code (ICBN Art. 9.2 & Note 2) and acceptable as lectotypes. These specimens are clearly somewhat aberrant forms of *C. revoluta* lacking petiolar spines. *C. miquelii* must therefore fall into the synonymy of *C. revoluta*. *Cycas inermis* is a distinct species from southern Vietnam (see Hill et al. 2004). The neotypification in de Laubenfels and Adema (1998: 393) is based on a specimen of a quite different species from southern Thailand (*C. clivicola*, see also under *C. sexseminifera*). This choice is redundant when the Utrecht specimens from the Amsterdam Botanic Garden are taken as original material. It is also in conflict with the protologue in that the specimen is not from southern China.

Distinguishing features: readily distinguished by the keeled, stiff leaves with crowded, stiff, narrow leaflets with strongly recurved or revolute margins and the tomentose ovules.

Distribution and habitat: widely distributed through the Ryukyu Islands of southern Japan, today primarily on steep to precipitous stony sites, but previously on flatter land now cleared. Reports of natural occurrences in coastal Fujian Province of China have not been substantiated in recent times, although circumstantial support for these claims is strong (Fig. 1).

Conservation status: a number of natural stands are in protected areas, and this species is in cultivation worldwide in vast numbers, from artificially propagated sources. No immediate threat is evident. The Ver 3.1:IUCN (2001) status is **NT** (Donaldson 2003) but is here regarded as **LC.**

Selected specimens examined: CHINA: Fujian: near Chekiang border, 600–1200m, *Ching 2260*, Aug 1924 (BM); Diongloh Hsien, Meihwa, *Chung 2045*, 29 Jul 1923 (K). **JAPAN:** Ins. Tanegashima, Nishino-Omote, *Ohwi & Okamoto TSM 994*, 7 Nov 1953 (B, K); Liukiu Is., wild on sea cliffs around Nahe, *Wilson 8058*, 11 Mar 1917 (K, NY); Ryukyu Is., Taketomi Shima, Omasu, NE of Hazama, *Fosberg 37634*, 19 Jun 1956 (K, NY); Ryukyu Is., Myako Jina, 0.5 km SE of Matsubara, *Fosberg 38242*, 14 Aug 1956 (K, NY); Ryukyu Is., Ishigaki Shima, 0.5 km S of Todoroki Gawa, *Fosberg 38117*, 31 Jul 1956 (K); Ryukyu Is., Okinawa Hontoo, Kiyan Itoman-shi, *Myshi Furuse 2413*, 10 Nov 1972 (K); Ryukyu, Ins. Okinawa, Oku, *Tamura 25854*, 9 Oct 1972 (B).

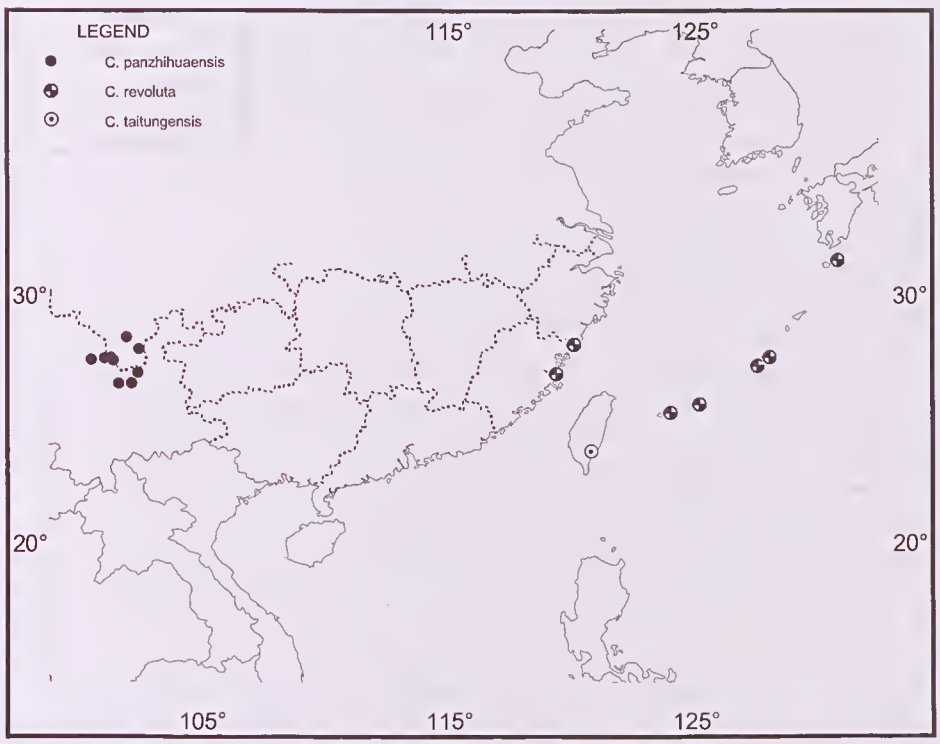

Fig. 1. Distributions of *C. panzhihuaensis, C. revoluta, C. taitungensis.*

2. *Cycas taitungensis* C.F.Shen, K.D.Hill, C.H.Tsou & C.J.Chen, Bot. Bull. Acad. Sin. 35: 135–138 (1994).

Type: Taiwan, Taitung Hsien, Yenping, in the Cycad Reserve, *Chi-Hua Tsou 825*, 28 Jun 1993 (holo HAST; iso A, BM, K, NSW, NY, P, PE, TAI).

Literature: Li (1980), Wang (1996).

Illustrations: Cheng et al. (1975), Li (1980), Wang (1996).

Etymology: from the prefecture of Taitung, a mountainous region in south-eastern Taiwan, where this species is native, with the Latin termination -ensis, place of origin.

Vernacular: Chinese - *tai-dong su-tie, feng-wei-jiao* (Phoenix-tail grass or palm); English (hort.) - *emperor sago* (Chen et al. 1995, Bonta & Osborne 2007).

Stems arborescent, to 3(–6) m tall, 25–30 cm diam. at narrowest point. *Leaves* deep green, semiglossy, 100–180 cm long, moderately keeled (opposing leaflets inserted at 120–150° on rachis), with 150–170 leaflets, with orange tomentum shedding as leaf expands; rachis usually terminated by a spine; petiole 15–20 cm long (15–20% of total leaf), petiole glabrous, spinescent for 50–90% of length; basal leaflets gradually reducing to spines, c. 30 mm long, spines 1–3 mm long. *Median leaflets* simple, strongly discolorous, 120–170 mm long, 6–8 mm wide, inserted at 45–60° to rachis, decurrent for 2.5–4.5 mm, narrowed to 2–2.5 mm at base (to 30–45% of maximum width), 4.5–6 mm apart on rachis; section slightly keeled; margins recurved; apex acute, spinescent; midrib flat above, raised below. *Cataphylls* linear, pungent, densely floccose, 7–11 mm long. *Pollen cones* fusiform, yellow, 35–50 cm long, 8.5–10 cm diam.; microsporophyll lamina waxy, not dorsiventrally thickened, 35–40 mm long, 11.5–15 mm wide, fertile zone 25–30 mm long, sterile apex 4.5–10 mm long, apical spine absent; apex deflexed, 6 mm long. *Megasporophylls* 21–26 cm long, brown-tomentose; ovules 2–6, pubescent; lamina orbicular, 100–130 mm long, 80–100 mm wide, deeply pectinate, with 28–36 soft lateral spines 35–45 mm long, 1.5–3 mm wide, apical spine not distinct from lateral spines. *Seeds* oblong, 40–45 mm long, 25–30 mm wide; sarcotesta red, slightly pruinose, 1.5–3 mm thick; fibrous layer absent; sclerotesta longitudinally grooved; spongy endocarp absent.

Historical notes: although not described until 1994, this species was widely known previously under the misapplied name *C. taiwaniana*.

Distinguishing features: although very close to *C. revoluta*, this species is readily distinguished by the longer, flatter leaves with longer and flatter leaflets. Female cones also tend to be more tightly imbricate and cabbage-like, and seeds are darker in colour.

Distribution and habitat: known only from the mountainous southern parts of Taiwan, growing on steep to precipitous slopes (Fig. 1).

Conservation status: although a stand occurs in a nature reserve established specifically for this cycad, the area is small and subject to earth movement and erosion. Ver 3.1:IUCN (2001) status is **VU** (Donaldson 2003).

Selected specimens examined: CHINA: Taiwan: Taitung County, inter Sesui et Matuyama, *Yamamoto & Goto*, 28 Dec 1928 (TAI 194156, TAI 194157, TAI 194159); Taitung, *Hsieh & Tsou s.n.*, Nov 1992 (PE). **Cult.:** Burpengary, Queensland, Australia, from seed from Taitung, Taiwan, *Walkley NSW 265951*, Feb 1993 (NSW); Ningyang, Fujian, China, from Taitung, Taiwan, *Lin 5562* (PE); Xianhe Bot. Gard., Shenzen, China, from Taitung, Taiwan, *Chen 92589* (PE); Kaede Taito-cho, *Tanaka 10451*, 7 Mar 1931 (BM, NY).

B. Section **PANZHIHUAENSES** (D.Yue Wang) K.D.Hill, stat. nov.

Cycas subgenus *Panzhihuaenses* D.Yue Wang, Cycads China 26 (1996).

Type: *C. panzhihuaensis* L.Zhou & S.Y.Yang

This section is defined by the firm, waxy microsporangiate cones and microsporophylls, the pectinate megasporophyll apices, the glabrous ovules, and the red to orange seeds with a non-fibrous sarcotesta and a smooth, unornamented sclerotesta. The circumscription as applied here includes only the type species, in contrast to the circumscription of Wang (1996). The group is relictual, and includes only a single species occuring in south-western China (Fig. 1). Although firm and waxy as developing, male cones and microsporophylls become soft and break down quickly afer maturity. This section shares deeply encrypted stomata with section *Asiorientales*.

3. *Cycas panzhihuaensis* L.Zhou & S.Y.Yang, Acta Phytotax. Sin. 19(3): 335, Tab. 10, Fig. 1–6; Tab. 11, Fig. 1–10 (1981).

Type: China, Sichuan, Dukou, Baguan He, Yang Siyuan 10 (holo PE).

Cycas baguanheensis L.K.Fu & S.Z.Cheng, Acta Phytotax. Sin. 19(3): 337 (1981).

Type: China, Sichuan, Dukow Shi (Panzihua City), Yang Si-Yuan & Wu Bin 13, 1979 (holo PE). Included in *C. panzhihuaensis* by Zhou and Yang (1981).

Literature: Wang (1996).

Illustrations: Wang (1996).

Etymology: from the natural occurrence of this species in the Panzihua Prefecture of southern Sichuan Province, China, with the Latin termination *-ensis*, place of origin.

Vernacular: Chinese - *e-bao-gong, e-boa-chi, Panzhihua su-tie* (Walters & Yang 1994, Bonta & Osborne 2007).

Stems arborescent, to 1–2(–3) m tall, 15–20 cm diam. at narrowest point; 30–80 leaves in crown. *Leaves* bluish, semiglossy, 70–150 cm long, flat (not keeled) in section (opposing leaflets inserted at 180° on rachis), with 140–250 leaflets, with orange tomentum persistent below; rachis consistently terminated by paired leaflets; petiole 7–25 cm long (15–25% of total leaf), petiole glabrous, spinescent for 50–70% of length; basal leaflets not gradually reducing to spines, 50–70 mm long, spines 1–3 mm long. *Median leaflets* simple, strongly discolorous, 120–230 mm long, 5–7 mm wide, inserted at 50–60° to rachis, decurrent for 4–6 mm, narrowed to 2–3 mm at base (to 35–45% of maximum width), 6–10 mm apart on rachis; section flat; margins flat to slightly recurved; apex aristate, spinescent; midrib flat above, raised below. *Cataphylls* narrowly triangular, soft, densely brown floccose, 60–90 mm long. *Pollen cones* fusiform, yellow, 25–50 cm long, 8–14 cm diam.; microsporophyll lamina waxy, not dorsiventrally thickened, 40–60 mm long, 18–32 mm wide, fertile zone 30–40 mm long, sterile apex 8–11 mm long, deflexed; apical spine rudimentary, deflexed, 1–4 mm long. *Megasporophylls* 11–21 cm long, yellow-tomentose or brown-tomentose; ovules 1–5, glabrous; lamina orbicular, 70–150 mm long, 35–70 mm wide, deeply pectinate, with 23–40 soft lateral spines 10–40 mm long, 2–2.5 mm wide, apical spine not distinct from lateral spines. *Seeds* subglobose, 25–35 mm long, 22–30 mm wide; sarcotesta red to orange, not pruinose, 1.5 mm thick; fibrous layer absent; sclerotesta smooth; spongy endocarp absent.

Historical notes: probably the most abundant Chinese cycad, although only recently described. This species was named in 1981 by Chinese horticulturists Lin Zhou and Si-Yuan Yang, based on specimens that Yang and Bin Wu had collected near Dukou, now Panzhihua City, in 1979. In the same paper, Chinese botanists Li-Kuo Fu and Shu-Zhi Cheng from the Institute of Botany in Beijing described *C. baguanheensis*, based on collections by Yang and Wu from Baguan He, also near Panzhihua City, collected on the same expedition in 1979. It has been generally accepted subsequently, however, that the latter was merely a depauperate form of the former from a harsher site (Guan 1983, Zhou 1990).

Distinguishing features: one of the most distinct of the Chinese cycads, characterised by the flat, erect leaves with narrow, dull bluish leaflets and the small, orange-red seeds.

Distribution and habitat: known from southern Sichuan and northern Yunnan Provinces (Fig. 1), typically in fairly dry, closed low woodland or shrubland thickets on moderately to steeply sloping sites. Soil is usually derived from limestone, although occurrences on shale and sandstone are known. As with all mainland Asian cycads, human population pressure has had considerable impact, and present distributions may represent a small fraction of the distribution of only a century ago.

Conservation status: although populations numbering hundreds of thousands were recently recorded (Zhou 1990), and two nature reserves have been designated for the protection of this species, it must still be regarded as potentially endangered. Much of the habitat is under immediate threat of clear cutting for fuel and agricultural land, and plants are being extensively collected for sale as food, medicine and ornamentals, even within the reserves (Walters et al. 1995). Ver 3.1:IUCN (2001) status is **NT** (Donaldson 2003).

Selected specimens examined: CHINA: Yunnan: Yan Mou, Longjie, *Wu 840103*, May 1984 (KUN); Lu Quan county, *Li 03* (KNF).

C. Section **STANGERIOIDES** Smitinand

Cycas section *Stangerioides* Smitinand, Nat. Hist. Bull. Siam. Soc. 24: 168 (1971). Type: *C. micholitzii* Dyer.

This section is defined by the soft microsporangiate cones and microsporophylls, the pectinate megasporophyll apices, the glabrous ovules, and the yellow seeds with a non-fibrous, loose, freely peeling sarcotesta, and a verrucose sclerotesta. It is a taxonomically complex group, circumscribed as by Hill (1995), rather than Smitinand (1971) or Wang (1996), although present knowledge would also suggest exclusion of the Chinese species *C. panzhihuaensis* from the section. The group encompasses most of the Chinese species, and ranges from northern Thailand and north-eastern Myanmar east through Laos, Vietnam and southern China. Seventeen species occur in China, in the south and east (Figs. 2–5).

4. ***Cycas guizhouensis*** Lan & R.F.Zou, Acta Phytotax. Sin. 21(2): 5 (1983).

Type: China, Guizhou: cultivated in hospital of Xingyi (plants originally introduced from Wantun, Xingyi), 10 Aug 1981, *K.M. Lan et R.F. Zou 81–8–0001* (holotype in Herb. Guizhou Agr. Coll; iso PE).

Cycas multiovula D.Y.Wang, Cycads China: 83 (1996).

Type: cultivated in Gejiu, Yunnan, China, *D.Y. Wang 5574* (holo SZG; isotypes IBSC, NF).

Literature: Wang (1996).

Illustrations: Wang (1996).

Etymology: from Guizhou province, with the Latin termination -ensis, place of origin.

Vernacular: Chinese - *feng-wei-cao* (Phoenix-tail grass or palm), *feng-wie-tie, feng-wei su-tie, Guizhou su-tie, Nanpan jiang su-tie* (Nanpan River cycad), (qiannian), *guan-yin-lian, shan-bo-lou, su-tie* (Walters & Yang 1994, Bonta & Osborne 2007).

Stems arborescent to acaulescent, to 1 m tall, 10–15 cm diam. at narrowest point; 5–20 leaves in crown. *Leaves* deep green, semiglossy, 100–180 cm long, slightly keeled (opposing leaflets inserted at 130–170° on rachis), with 110–210 leaflets, with orange tomentum shedding as leaf expands; rachis consistently terminated by paired leaflets; petiole 30–60 cm long (25–40% of total leaf), petiole glabrous, spinescent for 40–100% of length but not spinescent across swollen base; basal leaflets not gradually reducing to spines, 110–200 mm long; spines 1–4 mm long. *Median leaflets* simple, strongly discolorous, 160–370 mm long, 8–12 mm wide, inserted at 55–65° to rachis, decurrent for 4–5 mm, narrowed to 2.5–3 mm at base (to 30–40% of maximum width), 10–16 mm apart on rachis, somewhat twisted (insertion not parallel to rachis); section slightly keeled; margins flat, or slightly recurved; apex acute, not spinescent; midrib raised above, flat below or raised below. *Cataphylls* narrowly triangular, soft, pilose, 50–80 mm long. *Pollen cones* fusiform, orange to brown (very pale), 20–40 cm long, 6–14 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, 30–40 mm long, 17–20 mm wide, fertile zone 27–36 mm long, sterile apex 3–5 mm long, level, apical spine absent. *Megasporophylls* 10–20 cm long, yellow-tomentose or brown-tomentose; ovules 4–8, glabrous; lamina orbicular, 60–70 mm long, 60–80 mm wide, deeply pectinate, with 17–33 soft lateral spines 20–45 mm long, 2–4 mm wide, apical spine distinct from lateral spines, 25–45 mm long, 9–17 mm wide at base. *Seeds* subglobose, 23–29 mm long, 22–28 mm wide; sarcotesta yellow, not pruinose, 1.5 mm thick; fibrous layer absent; sclerotesta smooth or verrucose; spongy endocarp absent.

Historical notes: when described in 1983 by Chinese botanists K.M. Lan and R.F. Zou, this species was contrasted with *C. pectinata*, although its affinities are actually with the group of Chinese cycads that includes *C. balansae* and *C. taiwaniana*. The type was collected by Lan and Zou from a cultivated plant in the grounds of the Xingyi hospital in 1981, although wild collections were also known. The type of *C. multiovula* was later collected from the same place.

Distinguishing features: within the group of Chinese cycads with soft pollen cones, loose, freely peeling sarcotesta lacking a fibrous layer and verrucose sculpting of the sclerotesta (Section *Stangerioides*), this species is distinguished by the narrow leaflets and small stature, with a petiole that is usually not wholly spinescent, and leaves that are slightly keeled with leaflets distinctly twisted on the rachis. Pollen cones are also quite large (to 40 cm long).

Distribution and habitat: this species is known from the Nanpan and Qingshui valleys in south-western Guizhou province, eastern Yunnan and north-western Guangxi provinces (Fig. 2). It is typical of low, scrubby forests on steep slopes on limestone bluffs or screes.

Conservation status: Walters et al. (1995) report extensive destruction of this species during the cultural revolution, regarding it as the most seriously threatened of all Chinese cycads. They also report that the Qian-Xu-Nan Prefecture Department of Forestry in Xing-yi has abandoned hope of in situ protection (in that prefecture), and are concentrating on ex situ conservation collections. More recent studies indicate however that this species is moderately abundant over a considerable area around the common borders of Guizhou, Guangxi and Yunnan provincesIt is listed by the 1997 IUCN Red List of Threatened Plants as category V, although considerable confusion is shown by the inclusion of *C. szechuanensis* as a synonym, and then the listing of the latter separately as category Ex (see also *C. szechuanensis*). Ver 3.1:IUCN (2001) status is **NT** (Donaldson 2003).

Selected specimens examined: CHINA: Guangxi: cultivated in Longlin city, Collected nearby, *C.J. Chen, Y.C. Zhong & K.D. Hill 24, 25,* 15 Nov 1998 (NSW, FTG HN, NY, PE); cultivated in Xingyi city, Collected nearby, *C.J. Chen, Y.C. Zhong & K.D. Hill 27,* 16 Nov 1998 (NSW, HN, L NY, PE); Long Xui Ten locality, Gao Feng village, Ya Zha town, N of Longlin city, *C.J. Chen, Y.C. Zhong & K.D. Hill 26,* 16 Nov 1998 (NSW, HN, K NY, PE).

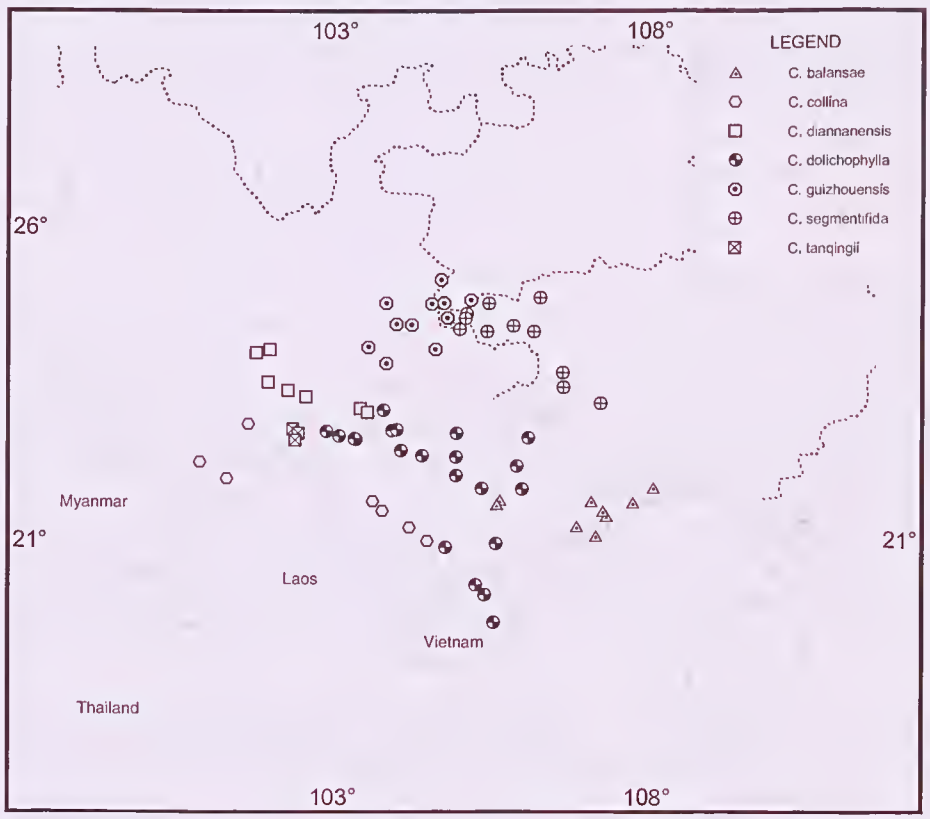

Fig. 2. Distributions of *C. balansae, C. collina, C. diannanensis, C. dolichophylla, C. guizhouensis, C. segmentifida* and *C. tanqingii.*

5. *Cycas segmentifida* D.Y.Wang & C.Y.Deng, Encephalartos 43: 11 (1995).

Type: cultivated, South China Botanical Garden, Guangzhou, China, *D.Y. Wang & H. Peng 2967*, 16 May 1994 (holo SZG; iso FTG n.v., GZAC n.v., NF n.v., NSW, XIN n.v.).

Cycas longiconifera Hung T.Chang, Y.C.Zhong & Y.Yuan Huang, *Acta Sci. Nat. Univ. Sunyatseni* 37(4): 6 (1998).

Type: China, Guangxi, Baise, alt. 850 m, in calceo-saxo, *Y.C. Zhong 8771*, 26 Mar 1998 (holo SYS). Included in the synonymy of *C. segmentifida* by Chen and Stevenson (1999).

Cycas longlinensis Hung T.Chang & Y.C.Zhong, Acta Sci. Nat. Univ. Sunyatseni 36: 68 (1997).

Type: China, Guangxi, Longlin, Mt Jin Zhong Shan, alt. 860 m, in arenoso-saxum, *Y.C. Zhong 80848*, 14 Dec 1991 (holo SYS). Included in the synonymy of *C. segmentifida* by Chen and Stevenson (1999).

Cycas multifida Hung T.Chang & Y.C.Zhong, *Acta Sci. Nat. Univ. Sunyatseni* 36: 70 (1997).

Type: China, Guanxi, Xiling, in arenoa-saxa, alt. 780 m, *Y.C. Zhong 80196*, 27 Jun 1995 (holo SYS). Included in the synonymy of *C. segmentifida* by Chen and Stevenson (1999).

Cycas xilingensis Hung T.Chang & Y.C.Zhong, *Acta Sci. Nat. Univ. Sunyatseni* 36: 69 (1997).

Type: China, Guanxi, Xiling, alt. 880 m, *Y.C. Zhong 80866*, 18 Jul 1994 (holo SYS). Included in the synonymy of *C. segmentifida* by Chen and Stevenson (1999).

Literature: Chen and Stevenson (1999), Chen and Liu (2004).

Illustrations: Wang (1996).

Etymology: from the Latin, *segmentifida*, divided into segments, from the deeply divided megasporophyll.

Stems acaulescent or arborecent, to 0.5 m tall, 10–23 cm diam. at narrowest point, 8–25 leaves in crown. *Leaves* deep green, highly glossy, 120–280 cm long, flat (not keeled) in section (opposing leaflets inserted at 180° on rachis), with 80–190 leaflets, with orange tomentum shedding as leaf expands; rachis consistently terminated by paired leaflets; petiole 40–140 cm long (30–50% of total leaf), glabrous, spinescent for 90–100% of length; basal leaflets not gradually reducing to spines, 70–290 mm long; spines 1–4 mm long. *Median leaflets* simple, strongly discolorous, 120–420 mm long, 9–20 mm wide, inserted at 50–80° to rachis, decurrent for 4–7 mm, narrowed to 3–7 mm at base (to 30–50% of maximum width), 11–24 mm apart on rachis, inserted parallel to rachis; section flat; margins flat, sometimes undulate; apex acute, not spinescent; midrib raised above, raised below. *Cataphylls* narrowly triangular, soft, pilose, 70–100 mm long. *Pollen cones* fusiform, yellow, 30–60 cm long, 5–12 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, 20–30 mm long, 15–18 mm wide, fertile zone 17–27 mm long, sterile apex 3 mm long, level, apical spine absent. *Megasporophylls* 16–25 cm long, yellow-tomentose or brown-tomentose; ovules 4–8, glabrous; lamina orbicular, 80–130 mm long, 50–120 mm wide, deeply pectinate, with 16–44 soft lateral spines 20–70 mm long, 2–3 mm wide, apical spine distinct from lateral spines, 25–125 mm long, 8–20 mm wide at base. *Seeds* subglobose, 28–35 mm long, 24–30 mm wide; sarcotesta

yellow, not pruinose, 1.5 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Historical notes: reports of an unidentified species from Longlin county in north-western Guangxi (Sykes 1991) probably refer to this species.

Distinguishing features: within the group of Chinese cycads with soft microsporangiate cones, loose, freely peeling sarcotesta lacking a fibrous layer and verrucose sculpting of the sclerotesta (Section *Stangeriales*), this species is distinguished by the small seeds, broad leaflets with flat or undulate margins, leaflets that are flat and not twisted on the rachis, and a large megasporophyll apex with a broad apical spine.

Distribution and habitat: once an extremely widespread species through western Guangxi, extending into southern Guizhou and eastern Yunnan, in both cases to a limited extent (Fig. 2). This species occurs on a range of substrates from limestone to shale and schist, usually on steep slopes lower in valleys with some although often skeletal soil cover. Vegetation ranges from closed evergreen forest to mixed deciduous and evergreen woodland, although today is mostly severely degraded to grassland or scrubby secondary regrowth.

Conservation status: this species was moderately abundant over a considerable area in western Guangxi province, but now severely depleted. Ver 3.1:IUCN (2001) status is **VU** (Donaldson 2003).

Selected specimens examined: CHINA: Guangxi: Debao County, Ba Gen village, 5 km from Debao city, *Chen, Zhong & Hill 07*, 9 Nov 1998 (BKF, HN, K, NY, P, PE); Debao County, side road from main Debao to Baise road, *Chen, Zhong & Hill 09*, 10, 9 Nov 1998 (NSW, PE); Tianlin County, Yan Ron locality, Wei Hua village, Le Li town, 10 km SW of Tianlin city, *Chen, Zhong & Hill 11, 12*, 10 Nov 1998 (NSW, PE); Tianlin County, Fu Da town, S of Tian Lin city, cultivated in town, collected from nearby, *Chen, Zhong & Hill 15*, 11 Nov 1998 (NSW, PE); Xilin County, Long Lo Tun locality, Po Ning village, Ba Da town, ca 3 km SE of Xilin city, type locality for *C. xilingensis*, *Chen, Zhong & Hill 17*, 12 Nov 1998 (NSW, PE); Xilin County, Zhou Bong village, ca 9 km NE of Xilin city, type plant of *C. multifida*, *Chen, Zhong & Hill 18*, 12 Nov 1998 (NSW, PE); Xilin County, Zu Be town, ca 3 km SE of Xilin city, *Chen, Zhong & Hill 19*, 13 Nov 1998 (NSW, PE); Longlin County, Liu Long Guo, near Bian Ya town, E of Longlin city, *Chen, Zhong & Hill 20*, 15 Nov 1998 (NSW, PE). **Yunnan:** cult. in Funing Middle Vocational School garden, plants coll. from wild near Bo'ai, *Chen, Hong, Hill & Stevenson 001(Hong 327)*, 2 Jul 2000 (PE, YAF, IBSC, NSW, NY); cult. in Wenshan Forestry Office, plants coll. from wild at Ake, Guangnan County , *Chen, Hong ,Hill & Stevenson 002 (Hong 328)*, 3 Jul 2000 (PE, YAF, IBSC, NSW, NY).

6. *Cycas dolichophylla* K.D.Hill, H.T.Nguyen & L.K.Phan, Bot. Rev. 70(2): 157–160, fig. 7 (2004).

Type: Vietnam: Tuyen Quang: Na Hang, Pu La mountain, 2 Nov 1996, *H.T. Nguyen 2124* (holo HN)

Etymology: from the Greek *dolichos*, long, and *phyllon*, leaf, referring to the long leaves.

Stems arborescent, to 1.5 m tall, 18–30 cm diam. at narrowest point. 8–40 leaves in crown. *Leaves* bright green to deep green, highly glossy, 200–450 cm long, flat (not keeled) in section (opposing leaflets inserted at 180° on rachis), with 150–270 leaflets, with orange tomentum shedding as leaf expands; rachis consistently terminated by paired leaflets; petiole 40–110 cm long (20–35% of total leaf), glabrous, spinescent

for 90–100% of length; basal leaflets not gradually reducing to spines, 90–240 mm long; spines 4–10 mm long. *Median leaflets* simple, strongly discolorous, 190–420 mm long, 14–25 mm wide, inserted at 60–85° to rachis, decurrent for 5–8 mm, narrowed to 3–6 mm at base (to 20–35% of maximum width), distinctively rounded at base, 16–30 mm apart on rachis, inserted parallel to rachis; section flat; margins undulate; apex softly acuminate, not spinescent; midrib raised above, flat below. *Cataphylls* narrowly triangular, soft, pilose, 80–120 mm long. *Pollen cones* narrowly ovoid or fusiform, yellow, 35–58 cm long, 8–10 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, 30–36 mm long, 9–13 mm wide, fertile zone 27–34 mm long, sterile apex 2–4 mm long, level; apical spine rudimentary or absent, sharply upturned, 0–3 mm long. *Megasporophylls* 15–26 cm long, brown-tomentose; ovules 2–4, glabrous; lamina orbicular, 60–120 mm long, 50–100 mm wide, deeply pectinate, with 16–26 soft spines 40–50 mm long, 2–3 mm wide, apical spine not distinct from lateral spines. *Seeds* ovoid or flattened-ovoid or oblong, 40–64 mm long, 33–36 mm wide; sarcotesta yellow, not pruinose, 2–4 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Historical notes: although the most widespread and abundant cycad in northern Vietnam, *C. dolichophylla* was recognised as a distinct species only in the late 1990's.

Distinguishing features: the robust though usually short aerial trunk, the longer and more numerous leaves with more numerous leaflets that are short, broad and distinctively rounded at the base, the long slender petiolar spines and the larger microsporangiate cones with rounded microsporophylls that lack any apiculus distinguish this species. Megasporophylls are similar to those of *C. balansae*, but larger and more robust. *C. dolichophylla* is also part of the complex of closely related taxa that is distributed through northern Vietnam, Laos, northern Thailand and Yunnan and Guangxi in southern China (Section *Stangerioides*). Within this section, a subgroup that may be a natural group is defined by a robust habit with a stout erect aerial trunk. This subgroup is mainly Chinese (including *C. hainanensis, C. taiwaniana* and *C. diannanensis*), with *C. dolichophylla* the only member of the group known to extend beyond China.

Distribution and habitat: locally frequent in more sheltered sites in deep shade in tall closed evergreen forests, from near the Chinese border in the north and north-west to Ben En National Park in Thanh Hoa province in the south, extending north-west to a very short way into eastern Yunnan province (Fig. 2). This species occurs on loamy soils over limestone, shale, schist or granite, in closed evergreen forests, although today these are often reduced to scrubby regrowth and bamboo scrub.

A population occurring west of the city of Moc Chau in Vietnam has narrow leaflets with slender bases, short to medium petioles and small seeds, and is interpreted as a zone of intergradation with *C. collina*, which is abundant in higher country to the west (specimens cited under *C. collina*). Plants observed in cultivation around Vo Nhai and Yen Son districts, Thai Nguyen Province, Vietnam, were intermediate in form between *C. dolichophylla* and *C. ferruginea*, and have been interpreted as hybrid individuals. In this region, *C. ferruginea* is abundant on steep exposed limestone faces, and *C. dolichophylla* is abundant in adjacent closed forests on deep heavy soils (specimens cited below). Plants observed in cultivation in villages west of Thai Nguyen, Vietnam, and said to have been collected locally were morphologically intermediate between *C. dolichophylla* and *C. bifida*

Conservation status: Ver 3.1:IUCN (2001) status is **VU** (Donaldson 2003).

Selected specimens examined: CHINA: Yunnan: Hekou county, Anjiahe district, cult. in Machang village, plants coll. from wild at Yang Hui village, *Chen, Hong, Hill & Stevenson 003 (Hong 329)*, 4 Jul 2000 (PE, YAF, IBSC, NSW, NY);Hekou county, Nanxi town, Xiaonanxihe, at 132 km of the highway, Batou , *Chen, Hong, Hill & Stevenson 004, 005 (Hong 332, 333)*, 4 Jul 2000 (PE, YAF, IBSC, NSW, NY); Pingbian County, Daoyao, Mutihe village, by Jingchang River, a tributary of Nanxi River, *Chen, Hong, Hill & Stevenson 007 (Hong 345)*, 5 Jul 2000 (PE, YAF, NSW, NY). **VIETNAM: Bac Can:** Bac Can city, cult., coll. from ca 13 km to SE, 15 Mar 1999, *Hill 5036 & Loc* (HN, NSW); Cho Moi, Tan Son, Nam Dat, ca 400 m. alt., 16 Mar 1999, *Hill 5037, 5038 & Loc* (HN, NSW). **Cao Bang:** Nguyen Binh, Huo Tham, Be Nuoc, ca 400 m. alt., 14 Mar 1999, *Hill 5032 & Loc* (HN, NSW). **Ha Giang:** Vi Xuyen, Viet Lam, Muc, 28 km S of Ha Giang city, cult. in village, coll. ca 3 km to NW, 26 Mar 1999, *Hill 5068 & Loc* (HN, NSW); Vinh Tuy, SE edge of Vinh Tuy townlet, cult. in garden, coll. ca 20 km SW, 26 Mar 1999, *Hill 5069 & Loc* (HN, NSW). **Lai Chau:** Phong Tho, Muong So, Vang Khon, cult. in village, coll. from steep limestone ridge behind village, 23 Mar 1999, *Hill 5064 & Loc* (HN, NSW); Phong Tho, Muong So, Phuong Lanh, 24 Mar 1999, *Hill 5065 & Loc* (HN, NSW). **Lao Cai:** Lao Cai city, cult., coll. 10 km to W or SW, 24 Mar 1999, *Hill 5066 & Loc* (HN, NSW); Bao Yen, Thuong Ha, 3rd village, 25 Mar 1999, *Hill 5067 & Loc* (HN, NSW). **Ninh Binh:** Cuc Phuong, 29 Dec 1994, *Hiep 2029* (HN); Nho Quan, Cuc Phuong National Park, near gate, cult. on old village site, thought to have been collected locally, 18 Mar 1999, *Hill 5049 & Loc* (HN, NSW); Nho Quan, Cuc Phuong National Park, near Bong, 18 Mar 1999, *Hill 5051 & Loc* (HN, NSW); Nho Quan, Cuc Phuong National Park, cult. in village at entrance gate, coll. nearby, 19 Mar 1999, *Hill 5052 & Loc* (HN, NSW). **Son La:** Moc Chau, Van Ho, Hang Trung, 20 km E of Moc Chau, 21 Mar 1999, *Hill 5057 & Loc* (HN, NSW). **Thai Nguyen:** Vo Nhai, Lau Thuong, Lung Hang, cult. near house, coll. 500 m to east, 16 Mar 1999, *Hill 5041, 5042 & Loc* (HN, NSW). **Thanh Hoa:** Nhu Xuan, Ben En National Park, 13 Oct 1996, *Hiep 2116, 2117, 2118* (HN); Nhu Thanh, Hai Van, Xuan Lai,19 Mar 1999, *Hill 5054 & Loc* (HN, NSW); Ngoc Lac, Minh Son, Minh Chau, cult. in village, coll. nearby, 20 Mar 1999, *Hill 5055 & Loc* (HN, NSW); Lang Chanh, Dong Luong, Thung, 20 Mar 1999, *Hill 5056 & Loc* (HN, NSW). **Tuyen Quang:** Chiem Hoa, Yen Nguyen, Dong Vang, 29 Mar 1996, *Yang & Hiep 768* (HN); 31 Mar 1996, *Yang & Hiep 774* (HN); Na Hang, Pac Ban, Nam Chang, 30 Mar 1996, *Yang & Hiep 769, 770* (HN); *Hiep 2083* (HN); Yen Son, Tien Bo, Goc Thi, cult in garden, coll from wooded hills close by, 17 Mar 1999, *Hill 5046 & Loc* (HN, NSW). **Hybrid swarm: *Cycas dolichophylla* X *C. ferruginea* VIETNAM: Thai Nguyen:** Vo Nhai, Lau Thuong, Lang Hang, cult. near house, coll. 500 m to east, 16 Mar 1999, *Hill 5039, 5040 & Loc* (HN, NSW); Quang Son, Dong Hai, cult. in gardens, coll. from steep limestone cliffs 3–400 m to W, 16 Mar 1999, *Hill 5045 & Loc* (HN, NSW).

7. *Cycas diannanensis* Z.T.Guan & G.D.Tao, *Sichuan Forestry & Desig.*, 1995: 1 (1995).

Type: China, Yunnan, S. Gejiu County, Manhao, alt 700–1120 m., *G.D. Tao 95014* (holo ISBC).

Cycas parvulus S.L.Yang, in D.Y.Wang, *Cycads China*: 93 (1996).

Type: China, Yunnan, around Mengdian village, Honghe County, 5 km from Yuanjiang [River], *S.L. Yang 317* (holo HWA n.v.; iso FTG n.v., PE). Study of the isotype held in PE and of living plants has led to the inclusion of this taxon in the synonymy of *C. diannanensis*.

Cycas pectinata var. *manhaoensis* C.Chen & P.Yun, *Acta Bot. Yunnan.* 17: 400 (1995).

Type: China, Yunnan, Gejiu, Manhao, 1210 m., *M.C. Cai & P. Yun*, 22, 19 Jun. 1995 (holo YUN). Included in the synonymy of *C. diannanensis* by Guan and Tao (1995).

Literature: Wang (1996, and also as *C. parvulus*).

Illustrations: Wang (1996, and also as *C. parvulus*).

Etymology: from the municipality of Diannan in Gejiu County, Yunnan Province.

Stems arborescent or acaulescent, to 3 m tall, 25–35 cm diam. at narrowest point, 12–50 leaves in crown. *Leaves* bright green or deep green, highly glossy, 140–330 cm long, slightly keeled or flat (not keeled) in section (opposing leaflets inserted at 160–180° on rachis), with 160–300 leaflets, with white or orange tomentum shedding as leaf expands; rachis terminated by a spine 1–11 mm long or paired leaflets; petiole 45–100 cm long (20–30% of total leaf), glabrous, spinescent for 90–100% of length; basal leaflets not gradually reducing to spines, 30–240 mm long; spines 1–4 mm long. *Median leaflets* simple, strongly discolorous, 130–320 mm long, 9–16 mm wide, inserted at 50–80° to rachis, decurrent for 3–7 mm, narrowed to 2.5–4 mm at base (to 20–30% of maximum width), 10–20 mm apart on rachis, inserted parallel to rachis; section flat; margins slightly recurved, sometimes undulate; apex acute, not spinescent; midrib raised above, raised below. *Cataphylls* linear, pungent, thinly sericeous or lacking tomentum, 120–200 mm long. *Pollen cones* narrowly ovoid, yellow, 50–65 cm long, 9–13 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, 35–60 mm long, 15–25 mm wide, fertile zone 30–50 mm long, sterile apex 4–10 mm long, raised; apical spine rudimentary, sharply upturned, 0–2 mm long. *Megasporophylls* 16–24 cm long, grey-tomentose; ovules 4–8, glabrous; lamina orbicular or ovate, 65–140 mm long, 55–140 mm wide, deeply pectinate, with 30–52 soft lateral spines 10–50 mm long, 1.5–4 mm wide, apical spine distinct from lateral spines, 10–45 mm long, 7–15 mm wide at base. *Seeds* ovoid, 28–40 mm long, 20–32 mm wide; sarcotesta yellow, not pruinose, 3–4 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Distinguishing features: within the group of Chinese cycads with soft microsporangiate cones, loose, freely peeling sarcotesta lacking a fibrous layer and verrucose sculpting of the sclerotesta (Section *Stangerioides*), this species is distinguished at once by the very long, prominent and pungent cataphylls, and also by the small seeds, broad leaflets with slightly recurved, sometimes undulate margins, leaflets that are flat and not twisted on the rachis, and a large megasporophyll apex with a broad apical spine.

Distribution and habitat: a widespread species through central and eastern Yunnan, along the Hong He valley between Hekou and Shuangbai (Fig. 2). This species occurs on a range of substrates from limestone to shale and schist, usually on steep slopes high on ridges, between about 600 and 1800 m. Original vegetation was closed evergreen forest in the cloud zone, although today it is often severely degraded to grassland or scrubby secondary regrowth.

Conservation status: this species is moderately abundant over a considerable area in central and eastern Yunnan province, but many populations are now depleted. Ver 3.1:1UCN (2001) status is **VU** (Donaldson 2003).

Selected specimens examined: CHINA: Yunnan: Gejiu county, Manhao, cult. in the garden of Lushuihe Hydroelectric Station Guest House, *Chen, Hong, Chu, Hill & Stevenson 16, 17 (Hong 369,370)*, 8 Jul 2000 (PE, YAF, IBSC, NSW, NY);Gejiu county, Manhao, Gougunpo, wild, *Chen, Hong, Chu, Hill & Stevenson 12 (Hong 351)*, 7 Jul 2000 (PE, YAF, NSW, NY); Juanjiang county, cult. in Qingshuihe Huashiban Hydroelectric Station, *Chen, Hong, Hill & Stevenson 23, 24 (Hong 408, 409)*, 15 Jul 2000 (PE, YAF, IBSC, NSW, NY);Xinping county, Yiao Jie, cult. in hospital garden, coll. nearby, *Chen, Hong, Hill & Stevenson 25, 26 (Hong 410, 411)*, 16 Jul 2000 (PE, YAF, IBSC, NSW, NY); Xinping county, Shui Tang, cult. in school garden, coll. nearby, *Chen, Hong,Hill & Stevenson 27 (Hong 412)*, 16 Jul 2000 (PE, YAF, IBSC, NSW, NY); Xinping county, Ga So, wild, *Hong 229*, 12 Dec 1999 (YAF); Shuang Bai county, *Li et al. 2216*, 23 Apr 1999 (YAF).

8. *Cycas collina* K.D.Hill, H.T.Nguyen & L.K.Phan, Bot. Rev. 70(2): 142 (2004).

Type: Vietnam: Son La: Mai Son, between Hat Lot and Bac Yen, 400–900 m alt., 5 Apr 1996, *S.L. Yang 777 & H.T. Nguyen* (holo HN).

Literature: Cheng et al. (1975, as *C. siamensis*), Wang (1996, as *C. balansae*).

Illustrations: Cheng et al. (1975, as *C. siamensis*), Wang (1996, as *C. balansae*).

Etymology: from the Latin *collinus*, pertaining to hills, from the occurrence at moderate to high elevations in mountainous country.

Vernacular: Chinese - *kong-que-bao-dan, shan-ba-buo, shen-xian-mi, xiang-wei-cai* (Walters & Yang 1994, as *C. simplicipinna*; Bonta & Osborne 2007, as *C. simplicipinna*).

Stems acaulescent, 10–20 cm diam. at narrowest point; 2–10 leaves in crown. *Leaves* deep green, highly to semiglossy, 180–330 cm long, slightly keeled (opposing leaflets inserted at 150–180° on rachis), with 90–190 leaflets, with orange and white tomentum shedding as leaf expands; rachis usually terminated by paired leaflets; petiole 70–190 cm long (35–55% of total leaf), glabrous, spinescent for 85–100% of length; basal leaflets not gradually reducing to spines, 120–260 mm long; spines 1–3 mm long. *Median leaflets* simple, strongly discolorous, 250–410 mm long, 15–23 mm wide, inserted at 60–85° to rachis, decurrent for 2–8 mm, narrowed to 2.5–4 mm at base (to 10–25% of maximum width), 16–27 mm apart on rachis, inserted parallel to rachis; section flat or slightly keeled; margins flat, often undulate; apex softly acuminate, not spinescent; midrib raised above, flat or slightly raised below, narrow. *Cataphylls* narrowly triangular, soft, pilose, 50–80 mm long. *Pollen cones* narrowly ovoid or fusiform, yellow, 25–60 cm long, 6–10 cm diam; microsporophyll lamina soft, not dorsiventrally thickened, 25–40 mm long, 14–19 mm wide; fertile zone 22–36 mm long, sterile apex 2–4 mm long, level; apical spine absent. *Megasporophylls* 8–14 cm long, yellow-tomentose, tomentum shedding; ovules 2–4, glabrous; lamina ovate, 50–70 mm long, 30–70 mm wide, deeply pectinate, with 12–22 soft lateral spines 15–35 mm long, 2 mm wide; apical spine not distinct from lateral spines. *Seeds* ovoid, 25–27 mm long, 20–22 mm wide; sarcotesta yellow, not pruinose, 2 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Historical notes: Chinese authors have misapplied the name *C. siamensis* to this taxon (Cheng et al. 1975). Later authors applied the names *C. simplicipinna* and *C. balansae* (Wang 1996; Chen & Stevenson 1999).

Distinguishing features: the larger and often more numerous leaves with more numerous leaflets and the larger male cones with rounded microsporophylls distinguish this species from *C. simplicipinna* and *C. balansae*. It is one of the complex of closely related acaulescent taxa with soft pollen cones, loose, freely peeling sarcotesta lacking a fibrous layer and verrucose sculpting of the sclerotesta (Section *Stangerioides*) that is distributed through northern Vietnam, Laos, northern Thailand and Yunnan and Guangxi in southern China. The lack of a distinct apical spine on the microsporophyll further distiguish this species within the group.

Distribution and habitat: locally frequent although not in dense stands, in more sheltered sites in deep shade in tall closed evergreen forests, mainly in the Sichuangbanna region of southern Yunnan province, China (Fig. 2). Also in mountainous regions mostly in Son La province in the north of Vietnam, above about 500 metres elevation, in evergreen or partly deciduous forests or woodlands or bamboo thickets on steep

slopes of mountain ridges. Substrate varies from red clay soils on limestone to loamy soils on metasediments. Probably also in Laos and Myanmar.

Conservation status: a widespread species, although not occurring in large or dense populations. Although its habitat is continually being reduced, many populations remain. Ver 3.1:IUCN (2001) status is **VU** (Donaldson 2003).

Selected specimens examined: CHINA: Yunnan: Pe-tsen, *Cavalerie 7106*, 1913 (K); Mengla county, Menglun Nature Reserve, *Chen, Hong, Hill & Stevenson (Hong 376–380)*, 12 Jul 2000 (YAF, PE); Jinghong county, Xishuangbanna region, Xaio Mung Yang Nature Reserve, *Chen, Hong, Hill & Stevenson (Hong 395, 396–400)*, 12 Jul 2000 (YAF, PE); dense forests of Nam Ha valley, beyond Muang Hai and Keng Hung, *J.F. Rock 2500*, 17 Feb 1922 (K); between Keng Hung and Muang Hing, 4000', *Rock 2654*, 25 Feb–1 Mar 1922 (E). **Cult.:** nursery of Nanning Forestry Research Centre, Nanning Guangxi, collected from Xishuangbanna region Yunnan, *Chen, Zhong & Hill 4*, 7 Nov 1998 (NSW, PE). **VIETNAM: Son La:** Yen Chau, Chieng Don, Chieng Dong pass, ca 8–900 m alt., *Hill 5061 & Loc*, 21 Mar 1999 (HN, NSW); Thuan Chau, Chieng Pac, Phang pass 21 km from Son La, ca 8–900 m alt., *Hill 5062 & Loc*, 22 Mar 1999 (HN, NSW); Phong Lai, ca 8–900 m alt., *Hill 5063 & Loc*, 22 Mar 1999 (HN, NSW); Mai Son, between Hat Lot and Bac Yen, 400–900 m alt., *Yang 777, 778 & Hiep*, 5 Apr 1996 (HN).

Intergrades: C. collina – C. dolichophylla: VIETNAM: Son La: Moc Chau, Chieng Hac, Chieng Pan, ca 500 m alt., *Hill 5060 & Loc*, 21 Mar 1999 (HN, NSW).

9. ***Cycas balansae*** Warb., Monsunia 1: 179 (1900).

Cycas siamensis subsp. *balansae* (Warb.) Schuster, Pflanzenr. 99: 81 (1932).

Type: (lectotype, here designated) Tonkin (Vietnam), Hanoi, Mar 1889, *B. Balansa 4084* (P; isolecto G-DC, G, K). See comment below.

C. shiwandashanica Hung T.Chang & Y.C.Zhong, Chinese Bull. Bot. 12: 12 (1995).

Type: Guangxi: Nasuo, Fangchenggang City, in broad-leaved forest, *Y.C. Zhong 88015*, 30 Jul 1990 (holo GXF; iso PE, SYS). Included in the synonymy of *C. balansae* by Chen and Stevenson (1999).

C. *palmatifida* Hung T. Chang, Y.Yuan Huang &Y.C.Zhong, Acta Sci. Nat. Univ. Sunyatseni 37(4): 7 (1998).

Type: China, Guangxi, cult. Nanning arboretum, *H.X. Zheng & Y.Y. Huang 98002*, 19 Apr 1998 (holo SYS n.v.). Although specimens were not seen, the living plant that the specimens were taken from was studied (see below), leading to the placement of this taxon in the synonymy of *C. balansae.*

C. tonkinensis, in part, sensu De Laubenfels and Adema (1998).

Literature: Wang (1996, and also as *C. shiwandashanica*), Chen and Stevenson (1999).

Illustrations: Cheng et al. (1975, as *C. siamensis*); Wang (1996, and also as *C. shiwandashanica*).

Etymology: honouring French naturalist and botanical explorer Benedict Balansa (1825–1892), who collected extensively for the Museum of Natural History in Paris, and spent the years 1885 to 1892 collecting in Tonkin (North Vietnam), where he died.

Stems acaulescent, 12–20 cm diam. at narrowest point, 4–9 leaves in crown. *Leaves* deep green, highly glossy to semiglossy, 120–260 cm long, slightly keeled to flat in section

(opposing leaflets inserted at 160–180° on rachis), with 90–160 leaflets, with dark brown tomentum shedding as leaf expands or persistent on petiole, rachis consistently terminated by paired leaflets; petiole 40–160 cm long (30–40% of total leaf), pubescent with dark purple-brown tomentum, spinescent for 100% of length, basal leaflets not gradually reducing to spines, 90–210 mm long; spines 4–10 mm long. *Median leaflets* simple, strongly discolorous, 220–300 mm long, 10–15 mm wide, inserted at 75–85° to rachis, decurrent for 5–8 mm, narrowed to 3–4 mm at base (to 25–35% of maximum width), 11–21 mm apart on rachis, inserted parallel to rachis, stiff in texture; section flat; margins flat or slightly recurved, apex softly acuminate; not spinescent, midrib raised above, flat below. *Cataphylls* narrowly triangular, soft, pilose, 60–70 mm long. *Pollen cones* fusiform, yellow, 20–25 cm long, 4–7 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, 16–30 mm long, 11–14 mm wide, fertile zone 14–28 mm long, sterile apex 2–4 mm long, level, apical spine absent. *Megasporophylls* 8–12 cm long; brown-tomentose; ovules 2–4, glabrous; lamina ovate, 40–60 mm long, 30–55 mm wide, deeply pectinate, with 14–24 soft spines 25–40 mm long, 2–3 mm wide, apical spine not distinct from lateral spines. *Seeds* ovoid, 25–27 mm long, 20 mm wide, sarcotesta yellow, not pruinose, 2 mm thick; fibrous layer absent; sclerotesta lightly verrucose; spongy endocarp absent.

Typification: described by German botanist Otto Warburg in 1900. A single collection was cited as 'Im Herbarium Barbey finde ich von Balansa sub Nr. 4084 gesammelte ♂ Zapfen aus Tongking, nahe Hanoi aus einem Tempelhof stammend…' Warburg types were mostly held by B, and Schuster (1932) cited a specimen probably from B which would probably have been the type: 'Tongking: Village du papier bei Hanoi, im Hof einer Pagode (B. Balansa IV. 1889, n. 4084).' This specimen was evidently destroyed in WW2. The specimens in G, K and P were not annotated by Warburg or Schuster, and may not have been seen by either. Most of these specimens are of microsporangiate cone material only, although the material held in P comprises two sheets, one microsporangiate cone portion and one leaf portion. The microsporangiate cone sheet is annotated 'B. Balansa - Pl. du Tonkin - 1885–1889/Nr. 4084/Dioique. Frondes de deux metres de hauteur/ Tongking: Village du papier près de Hanoi, dans la/cour d'une pagode/Avril 1889' [Dioecious. Fronds 2 m high. Paper village near Hanoi, in the garden of a pagoda]. The two sheets held in P are here designated the lectotype.

Distinguishing features: this species is one of the complex of closely related mostly acaulescent taxa that is distributed through southern China, northern Vietnam, Laos, and northern Thailand (Section *Stangerioides*). It is distinguished by the few long leaves with long petioles bearing long slender spines and a deep purple-brown tomentum that is often persistent. Microsporangiate cones are intermediate in size with rounded microsporophylls which lack any apiculus. Megasporophylls are reduced, with a few, long and slender divisions on the lamina. Seeds are small.

Distribution and habitat: locally frequent although not in dense stands, in more sheltered sites in deep shade in tall closed evergreen forests, in the Shiwandashan (mountains) in coastal south-eastern Guangxi province of China, and extending into the region north-west and north-east of Hanoi in Vietnam (Fig. 2). On loamy soils over schists or granites.

Conservation status: Ver 3.1:IUCN (2001) status is NT (Donaldson 2003).

Selected specimens examined: CHINA: Guangxi: Cult. grounds of Nanning Forestry Research Centre, Nanning (Type plant of *Cycas palmatifida*), collected from Fangcheng County, *Chen, Zhong & Hill 01*, 7 Nov 1998 (NSW, PE); cultivated in Ping Mu village, Na Suo town, Fangcheng county, Guangxi province, collected from Fang Chen Shang Yue reserve, *Chen, Zhong & Hill 28*, 19 Nov 1998 (NSW, PE). **VIETNAM: Hai Phong:** jardins a Hai Phong, 1885, *Balansa 563* (P). **Ha Nam:** Ke So, forte ex montibus Kien Khe, 25 May 1889, *Bon 4146* (P). **Lang Son:** Dinh Lap, Dinh Lap townlet (21°32'25"N 107°06'32"E), 12 Mar 1999, *Hill 5026, Loc & Dzu* (HN, NSW); Dinh Lap, Bac Lang, Ban Ha, 27 Mar 1996, *Yang & Hiep 763* (HN); Phu Son, Bac Son, Na Danh, 27 Mar 1996, *Yang & Hiep 765* (HN). **Quang Ninh:** Hoanh Bo, Tan Dan, Hang Tran (21°08'17"N 106°52'50"E), 11 Mar 1999, *Hill 5022, 5023, Loc & Dzu* (HN, NSW); Tien Yen, Dien Xa, Na Tru (21°22'47"N 107°17'32"E), 12 Mar 1999, *Hill 5025, Loc & Dzu* (HN, NSW); Cam Pha, 26 Mar 1996, *Yang & Hiep 758* (HN); Quang Nghia, Quang Ha, 27 Mar 1996, *Yang & Hiep 761* (HN); Hai Lang, Tien Yen, 25 Mar 1996, *Yang & Hiep 767* (HN). **Thai Nguyen:** Dai Tu, Ky Phu, Xom Gio, 19 Jan 2000, *Hiep 4117 & Hill* (HN, NSW). **Tuyen Quang:** Son Duong, Son Nam, cult. in restaurant, coll from NW side of Tam Dao range, Tam Dao, Dai Dinh, Den Thong, 17 Mar 1999, *Hill 5048 & Loc* (HN, NSW).

10. *Cycas tanqingii* D.Y.Yang, Cycads China: 134 (1996).

Type: China, Yunnan, Luchun County, *D.Y. Wang 5538* (holo SZG; iso NF n.v.).

Illustrations: Wang (1996).

Etymology: honouring Tan-Qing, director of the Shenzhen Fairy Lake Botanic Garden at the time this species was described.

Stems arborescent or acaulescent, to 2 m tall, 25–30 cm diam. at narrowest point, 4–7 leaves in crown. *Leaves* deep green, highly glossy, 190–360 cm long, flat (not keeled) in section (opposing leaflets inserted at 170–180° on rachis), with 100–160 leaflets, with orange tomentum shedding as leaf expands; rachis consistently terminated by paired leaflets; petiole 70–190 cm long (40–50% of total leaf), petiole glabrous, spinescent for 90–100% of length; basal leaflets not gradually reducing to spines; spines 1–4 mm long. *Median leaflets* simple, strongly discolorous, 300–450 mm long, 15–22 mm wide, inserted at 65–85° to rachis, decurrent for 2–3 mm, narrowed to 5–6 mm at base (to 20–30% of maximum width)15–27 mm apart on rachis, (inserted parallel to rachis); section flat; margins slightly recurved; apex aristate, not spinescent; midrib raised above, raised below. *Cataphylls* narrowly triangular, soft, pilose to densely floccose, 50–80 mm long. *Pollen cones* fusiform, yellow to orange, to 40 cm long, 5–8 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, 25–30 mm long, 10–13 mm wide, fertile zone 22–28 mm long, sterile apex 2–3 mm long, level to raised; apical spine slender, appressed, sharply upturned, 1.5–2 mm long. *Megasporophylls* 10–12 cm long, brown-tomentose; ovules 2, glabrous; lamina orbicular, 50–55 mm long, 50–65 mm wide, deeply pectinate, with 6–9 soft spines 15–40 mm long, 1–3 mm wide, apical spine not distinct from lateral spines, 20–45 mm long, 7–30 mm wide at base. *Seeds* subglobose to ovoid, 35–40 mm long, 30–35 mm wide; sarcotesta yellow, not pruinose, 2 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Distinguishing features: the robust habit with large leaves and long petioles, large microsporangiate cones and seeds distinguish this species within Section *Stangerioides*. *C. tanqingii* differs from *C. dolichophylla* in the longer and more widely spaced leaflets that are not broad-based and rounded at the base, and the longer petioles, although it may be more closely allied to *C. chevalieri* from Laos and Vietnam, differing in the overall larger stature.

Distribution and habitat: remote and mountainous country in south-eastern Yunnan Province, China (Fig. 2), possibly also across the border in Vietnam, in closed evergreen forest.

Conservation: Ver 3.1:IUCN (2001) status is **NT** (Donaldson 2003).

Selected specimens examined: CHINA: Yunnan: Luchun county, Erpu, along Xiaohejiang River (and Heishuhe River), *Chen, Hong, Chu, Hill & Stevenson 13–15 (355–357),* 9 Jul 2000 (PE, YAF, IBSC, NSW, NY). **VIETNAM: Lai Chau:** reported by forestry workers from Luchun County, China, to occur on Vietnamese side of the Hejiang [river], no voucher.

11. ***Cycas szechuanensis*** Cheng & L.K.Fu, Acta Phytotax. Sin. 13(4): 81, T. 1, Fig. 7–8 (1975).

Type: China, cultivated in Fuhu temple, Mt Emei, Sichuan, *J.H. Zhiong et al. 33221* (holo PE; iso HWA, IBSC, SZG, IBK) [citation is in Chinese].

Stems arborescent, to 2 m tall, 15–33 cm diam. at narrowest point; 6–40 leaves in crown. *Leaves* deep green, highly glossy, 120–380 cm long, slightly keeled to flat (not keeled) in section (opposing leaflets inserted at 160–180° on rachis), with 90–220 leaflets, with dark brown tomentum shedding as leaf expands; rachis consistently terminated by paired leaflets or a spine 8–25 mm long; petiole 50–130 cm long (25–40% of total leaf), petiole glabrous, spinescent for 95–100% of length; basal leaflets not gradually reducing to spines, 90–260 mm long; spines 1–3 mm long. *Median leaflets* simple, strongly discolorous, 230–440 mm long, 14–21 mm wide, inserted at 70–85° to rachis, decurrent for 4–7 mm, narrowed to 3.5–7 mm at base (to 20–50% of maximum width), 10–24 mm apart on rachis, twisted (insertion not parallel to rachis); section flat; margins flat; apex acute, not spinescent; midrib raised above, flat below to raised below (slightly). *Cataphylls* narrowly triangular, soft, pilose, 50–60 mm long. *Pollen cones* not seen. *Megasporophylls* 16–24 cm long, brown-tomentose; ovules 4–8, glabrous; lamina orbicular, 70–100 mm long, 60–110 mm wide, deeply pectinate, with 28–42 soft lateral spines 30–50 mm long, 2–4 mm wide, apical spine not distinct from lateral spines or distinct from lateral spines, 12–40 mm long, 2–8 mm wide at base. *Seeds* ovoid, to 45 mm long, to 35 mm wide; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Distinguishing features: *C. szechuanensis* is allied to *C. taiwaniana*, differing in the orbicular megasporophyll lamina that lacks a broad apical spine (2–8 mm wide in subsp. *fairylakea*, 7–30 mm wide in *C. taiwaniana*) and the larger seeds.

Two subspecies are recognised.

Key to the subspecies

Cataphylls less than 70 mm long, pilose ..... subsp. *szechuanensis*

Cataphylls more than 70 mm long, thinly sericeous ..... subsp. *fairylakea*

11A. *Cycas szechuanensis* subsp. *szechuanensis*

Etymology: from Szechuan (Sichuan) province, with the Latin termination -ensis, place of origin, in the mistaken assumption that this species was native to the region from which the cultivated type specimen was collected.

Stems arborescent, to 2 m tall, 15–25 cm diam. at narrowest point; 6–20 leaves in crown. *Leaves* deep green, highly glossy, 120–380 cm long, slightly keeled to flat (not keeled) in section (opposing leaflets inserted at 160–180° on rachis), with 90–220 leaflets, with dark brown tomentum shedding as leaf expands; rachis consistently terminated by paired leaflets; petiole 50–130 cm long (30–40% of total leaf), petiole glabrous, spinescent for 95–100% of length; basal leaflets not gradually reducing to spines, 90–260 mm long, spines 1–3 mm long. *Median leaflets* simple, strongly discolorous, 230–440 mm long, 14–21 mm wide, inserted at 80° to rachis, decurrent for 5–7 mm, narrowed to 3.5–4 mm at base (to 20–25% of maximum width), 10–24 mm apart on rachis, twisted (insertion not parallel to rachis); section flat; margins flat; apex acute, not spinescent; midrib raised above, flat below to raised below (slightly). *Cataphylls* narrowly triangular, soft, pilose, 50–60 mm long. *Pollen cones* not seen . *Megasporophylls* 16–24 cm long, brown-tomentose; ovules 4–8, glabrous; lamina orbicular, 70–100 mm long, 70–110 mm wide, deeply pectinate, with 28–34 soft lateral spines 30–50 mm long, 2–4 mm wide, apical spine not distinct from lateral spines. *Seeds* ovoid, to 45 mm long, 35 mm wide; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Historical notes: described in 1975 by Chinese botanists Cheng and Fu. This subspecies was rediscovered in the wild only in 1999, in eastern Fujian Province. Before this, it had been presumed extinct, or at one time regarded as conspecific with *C. guizhouensis* (Chen & Stevenson 1999).

Distribution and habitat: known only from eastern Fujian Province (Fig. 3). This subspecies grows in moist closed forests or woodlands.

Conservation status: this species is listed by the 1997 IUCN Red List of Threatened Plants (Walter & Gillett 1998; as *C. guizhouensis*) as category Ex. It has since been rediscovered in the wild, although known populations are severely degraded, and the overall reduction in recent years indicates that this species should probably be regarded as critically endangered. Ver 3.1:IUCN (2001) status is **CR** (Donaldson 2003).

Selected specimens examined: CHINA: Fujian: Yuing Tai County, Chin Yung town, Gu An village, cult., collected in district, *Chen 99008*, 26 Oct 199 (PE); Sha Ming County, Chon Da town, 500 m E of town, wild in hills, *Chen 99001*, 23 Oct 1999 (PE). **Cult.:** cultivated Guilin Institute of Botany, plants obtained from Guangdong many years ago, *Chen, Zhong & Hill 44*, 28 Nov 1998 (NSW, HN, K, NY, PE).

11B. *Cycas szechuanensis* subsp. *fairylakea*, (D.Yue Wang) N.Liu, Proc. Sixth Int. Conf. Cycad Biol.: 2 (2004).

Cycas fairylakea D.Yue Wang, Cycads China: 54 (1996).

Type: China, Guangdong, cultivated in South China Botanical Garden, *D.Y. Wang & H. Peng 2978*, 16 May 1994 (holo SZG; iso IBSC n.v., NF n.v.).

Literature: Wang (1996).

Etymology: from the Shenzhen Fairy Lake Botanic Garden, from which the cultivated type specimen was collected.

Stems arborescent, to 0.5–1.8 m tall, 22–33 cm diam. at narrowest point. 20–40 leaves in crown. *Leaves* deep green, highly glossy, 210–270 cm long, slightly keeled or flat (not keeled) in section (opposing leaflets inserted at 170–180 degrees on rachis), with 126–162 leaflets; rachis frequently terminated by a spine 8–25 mm long; petiole 49–80 cm

long (20–35 % of total leaf), glabrous, spinescent for 90–100 % of length; basal leaflets not gradually reducing to spines, spines 1–3 mm long. *Median leaflets* simple, 305–360 mm long, 12–19 mm wide, inserted at 70–85 degrees to rachis, decurrent for 4–6 mm, narrowed to 5–7 mm at base (to 30–50 % of maximum width), 20–22 mm apart on rachis, twisted (insertion not parallel to rachis); section flat; margins flat; apex acute, not spinescent; midrib raised above, flat below. *Cataphylls* linear, soft, thinly sericeous or lacking tomentum, 80–100 mm long. *Pollen cones* not seen. *Megasporophylls* 18–20 cm long, brown-tomentose; ovules 4–6, glabrous; lamina orbicular, 80–90 mm long, 60–70 mm wide, deeply pectinate, with 32–42 soft lateral spines 38–42 mm long, 2–3 mm wide; apical spine usually distinct from lateral spines, 12–40 mm long, 2–8 mm wide at base. *Seeds* not seen.

Historical notes: described at specific rank in 1996 by Chinese botanist D.Y. Yang. This subspecies was rediscovered in the wild only in 2000, near Shenzhen in eastern Guangdong Province. Before this, it had been regarded as conspecific with *C. taiwaniana* (Chen & Stevenson 1999).

Distinguishing features: subspecies *fairylakea* differs from the type subspecies in the presence of a distinctly extended though narrow apical spine on the megasporophyll and the longer, less pilose cataphylls.

Distribution and habitat: known only from eastern Guangdong Province. This subspecies grows in moist closed forests (Fig. 3).

Conservation status: although this subspecies has been rediscovered in the wild, known populations are severely degraded, and the overall reduction in recent years indicates that this subspecies should be regarded as threatened. Ver 3.1:IUCN (2001) status is **CR** (Donaldson 2003).

Selected specimens examined: CHINA: Guangdong: cult. Fairy Lake Botanical Garden, coll. from Fairy Lake 20 years ago, *Chen 2001–51*, 13 Jun 2001 (PE, NSW); Shenzhen, Tanglangshan, Changyuancun village, *Chen, Hill, Li, Wang, Zhang & Liu TL 001, 002, 003, 004, 005, 006*, 12 Jun 2001 (PE, NSW, SZG); *Liu, Jian, Ma & Wu 200152904*, 29 May 2001 (PE, NSW, SZG n.v.).

12. *Cycas taiwaniana* Carruth., J. Bot. 31: 1–3, Plate 331 (1893).

Type: Taiwan, Aug 1867, *Swinhoe s.n.* (holo BM; iso K).

Literature: Wang (1996).

Illustrations: Carruthers (1893).

Etymology: from Taiwan, from where this species was (erroneously) thought to have originated.

Vernacular: Chinese - *Feng Wei Cao* (phoenix tail grass) or *Feng Wei Jiao* (phoenix tail palm).*hai-tie-ou*, *Guangdong su-tie*, *Taiwan su-tie* (Walters & Yang 1994, Bonta & Osborne 2007).

Stems arborescent or acaulescent, to 3.5 m tall, 15–30 cm diam. at narrowest point; 12–30 leaves in crown. *Leaves* deep green, highly glossy, 150–300 cm long, slightly keeled or flat (not keeled) in section (opposing leaflets inserted at 160–180° on rachis), with 140–300 leaflets, with orange or brown tomentum shedding as leaf expands; rachis consistently terminated by paired leaflets; petiole 40–150 cm long (30–60% of total leaf), petiole glabrous, spinescent for 100% of length; basal leaflets not gradually reducing to spines c. 25 mm long; spines 1–4 mm long. *Median leaflets* simple, strongly

discolorous, 180–440 mm long, 9–16 mm wide, inserted at 45–85° to rachis, decurrent for 5–6 mm, narrowed to 3–5 mm at base (to 25–30% of maximum width), 10–24 mm apart on rachis, twisted (insertion not parallel to rachis); section flat; margins slightly recurved; apex aristate, spinescent; midrib raised above, flat below. *Cataphylls* narrowly triangular, pungent, pilose to densely floccose, 85–130 mm long. *Pollen cones* narrowly ovoid to fusiform, yellow, 30–45 cm long, 8–10 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, 20–30 mm long, 5–15 mm wide, apex level, apical spine absent. *Megasporophylls* 15–22 cm long, brown-tomentose; ovules 2–6, glabrous; lamina orbicular, 70–120 mm long, 55–70 mm wide, deeply pectinate, with 24–52 soft lateral spines 20–42 mm long, 1–2 mm wide, apical spine distinct or not distinct from lateral spines, 20–45 mm long, 7–30 mm wide at base. *Seeds* subglobose to ovoid, 28–36 mm long, 20–30 mm wide; sarcotesta yellow, not pruinose, 2 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Historical notes: *C. taiwaniana* was described in 1893 by English botanist and palaeontologist William Carruthers (1830–1922). The species was based on specimens he discovered in the herbarium of Henry F. Hance (a British consular officer in China from 1844 to 1886), which had since been acquired by the British Museum. These were collected by Robert Swinhoe, another British consular officer, who had also sent specimens to J.D. Hooker at Kew. The first of the latter was a single megasporophyll sent from the British Consulate at Amoy [Xiamen], where Swinhoe was the British

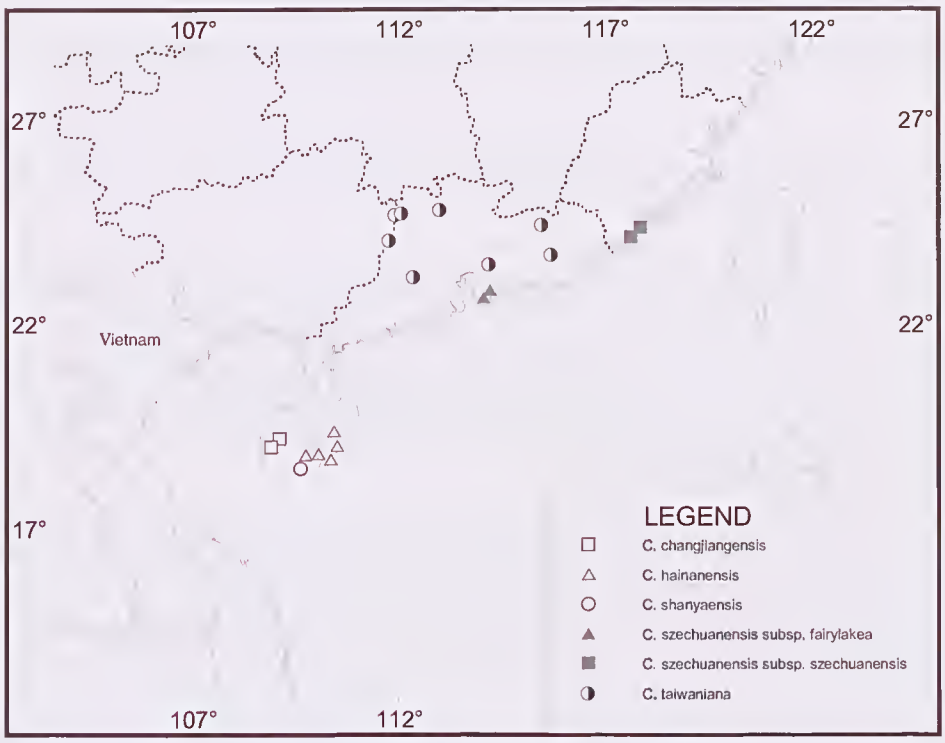

Fig. 3. Distribution of *C. changjiangensis, C. hainanensis, C. shanyaensis, C. szechuanensis* and *C. taiwaniana*.

representative, on 21 Aug 1867. This specimen was accompanied by a letter to Hooker in which Swinhoe wrote 'Among the [silkworm] cocoons now sent you will find two specimens of an extraordinary leaf. I have worked at it in vain to make out its relations. It looks like a botanical caricature of a Pelican. The Chinese call it Hai-te-koe or sea-iron fowl (sea-iron is the name given to the coral submarine trees), and use it to flavour tea. They tell me it is found in fresh-water wells, but it is so rare here that I have not been able to ascertain how it grows, and whether the leaf constitutes the entire plant…'. Swinhoe later the same year acquired more complete material, and sent additional specimens to both Hance and Hooker.

Carruthers in the protologue stated 'No more definite information is contained on the label than that the specimens were collected on the island of Formosa by Mr. Swinhoe, and sent to Dr. Hance in the autumn of 1867, from whose herbarium, as I have said, came the specimen in the British Museum on which the species is founded.' This statement is based on the annotation on the sheet, stating '*Cycas*, L./ *circinalis* L./ Ex insula Formosa,/ autumn 1867 misit/ cl. Swinhoe.' This annotation is not in Swinhoe's hand, and may have been made by Hance. There is no indication from Swinhoe of exactly where the specimens were collected.

Thiselton-Dyer (1902) addressed the problem of the origin of these specimens, and cited correspondence from British representatives in China to Kew. He stated that 'Mr. G. Phillips, H.B.M. consul at Takow [?] and later Swatow [Shantou] took much trouble to find Swinhoe's plant. He eventually discovered it in 1883 "on the hills 60 miles from Swatow" and sent specimens to Kew.' Phillips also wrote to Kew stating that he had never seen the plant in Taiwan, and that it was much sought after as a garden plant on the mainland. Thiselton-Dyer also cited specimens collected in the Lofu-Shan by Ford as this species, but did not recognize a distinction between the mainland and Taiwanese plants.

More recent Chinese accounts (Cheng et al. 1975, Cheng & Fu 1978) correctly apply the name *C. taiwaniana* to the mainland plants, but do not recognise the distinctive nature of the Taiwan plants (see *C. taitungensis*).

Distinguishing features: *Cycas taiwaniana* is placed with the wider group of Chinese species (Section *Stangerioides*) by the soft microsporangiate cones, the loose, freely peeling sarcotesta lacking a fibrous layer and the verrucose sclerotesta. Within this group, it is distinguished by the more robust stature with distinct development of an aerial trunk and a large crown of leaves, and small seeds. Megasporophylls usually have a distinct apex and are larger but extremely variable in outline, as with many of the species in this section. Leaflets are moderately narrow but again highly variable, and distinctly twisted on the rachis.

Distribution and habitat: widespread but sporadic, in Fujian, Guangdong, Guangxi, Guizhou and Hunan Provinces, China (Fig. 3). This species has long been cultivated in Guangdong and Fukien Provinces. Most collections, if not all, are from cultivated plants, and *C. taiwaniana* is now extremely rare in the wild. Reports of *C. taiwaniana* from Taiwan are the result of the misapplication of this name to the Taiwan cycad (*C. taitungensis*).

Conservation status: although originally widespread, this species has been severely depleted by collection from the wild and by habitat destruction over the centuries. Surviving populations are fragmentary and in remote sites and although probably reasonably secure by virtue of inaccessibility, must still be regarded as under threat.

This species is listed by the 1997 IUCN Red List of Threatened Plants as category V, but distribution is recorded in this listing as Hainan Island and Taiwan, which is clearly incorrect. Ver 3.1:IUCN (2001) status is **EN** (Donaldson 2003).

Selected specimens examined: CHINA: Guangxi: cultivated, He Xian Institute of Forestry, collected from near Guangdong border to east, from "soil mountain" in grass, *Chen, Zhong & Hill 38,* 25 Nov 1998 (NSW, NY, PE); cultivated Da Ning town, in schoolyard, collected from wild near Sang Ho village ca 10 km (3 hours walk) to east, growing naturally in semishade along stream, *Chen, Zhong & Hill 42,* 26 Nov 1998 (NSW, PE); cultivated, Ling Chuan city, N of Guilin, Guangxi, Plants collected from wild near Gui Bei, 150 km N of Guilin, growing along stream in semishade, red soil mountain, not limestone (probably sandstone), plants also across border in Hunan province, *Chen, Zhong & Hill 45,* 29 Nov 1998 (NSW, PE). **Guangdong:** Chin Tong village, San Sue town, in Li An Shan (mountains), probably cultivated, but said to occur naturally nearby, *Chen, Zhong & Hill 41,* 26 Nov 1998 (NSW, FTG, HN, K, KL, L, MO, NY, P, PE); Gaoyao County, *Shi 12204* (IBSC); Pingyuan County, *Deng 68300* (IBSC), *Deng 4410* (IBSC); Ruyuan County, *Tan 32* (IBSC), *Tan & Huang 321* (IBSC); Wengyuan County, *Lau 2653* (IBSC), *Lau 24847* (IBSC); Dinghu Shan, Zhaoqing County, *Xie & Li 00156* (IBSC). **Cult.:** Fujian, Xiamen, *Lin 2916* (IBSC); Guangdong, *Chen 88377* (PE); cultivated, Fen An Shi temple, Pu Meng town, *Chen, Zhong & Hill 39,* 25 Nov 1998 (NSW, PE); cultivated, near small market in He Xian city, *Chen, Zhong & Hill 40,* 26 Nov 1998 (NSW, FTG, HN, K, L, MO, NY, PE)

13. *Cycas hainanensis* C.J.Chen, Acta Phytotax. Sin. 13(4): 82, T. 2, Fig. 5–6 (1975).

Type: Hainan: Luilianling, Wangning County, 16 Oct 1961, *Y. Zhong 4706* (holo PE; iso IBSC n.v.).

Cycas lingshuiensis G.A.Fu, Bull. Bot. Res. 24(4): 387–388 (2004), as '*lingshuigensis*'.

Type: Hainan: Lingshui, hill mixed forest, alt 500–600m, 26 Dec 2002, G.A. Fu 10809 (holo HFB n.v.). Placed in the synonymy of *C. hainanensis* following discussions with Chinese botanists (pers. comm.).

Literature: Wang (1996, as *C. taiwaniana* in part and also as *C. fairylakea* in part).

Illustrations: Cheng et al. (1975), Wang (1996, as *C. taiwaniana* in part), Fu (2004, as *C. lingshuigensis*).

Etymology: from its natural occurrence in the island province of Hainan, with the Latin termination *-ensis*, place of origin.

(*C. lingshuiensis* from Lingshui town in southern Hainan province, with the Latin termination -ensis, place of origin. Originally published as *Cycas lingshuigensis* where the specific epithet has been formed incorrectly by the introduction of a superfluous letter 'g')

Vernacular: Chinese - *ci-bing su-tie* (spiny petioled cycad), *feng-huang-dan* (phoenix egg), *Hainan su-tie* (Chen et al. 1995, Walters & Yang 1994, Bonta & Osborne 2007).

Stems arborescent, to 0.3–1.5(–3.5) m tall, 30 cm diam. at narrowest point; 50–80 leaves in crown. *Leaves* bright green, highly glossy, 70–230 cm long, moderately keeled (opposing leaflets inserted at 120–160° on rachis), with 100–280 leaflets, with orange tomentum shedding as leaf expands; rachis usually terminated by paired leaflets; petiole 20–70 cm long (20–30% of total leaf), petiole glabrous, spinescent for 100% of length; basal leaflets not gradually reducing to spines, 140 mm long; spines 1–4 mm long. *Median leaflets* simple, strongly discolorous, 150–300 mm long, 6–10 mm wide, inserted at 40–70° to rachis, decurrent for 2–7 mm, narrowed to 2.5–3 mm at base

(to 30–45% of maximum width), 8–15 mm apart on rachis; section slightly keeled; margins slightly recurved; apex acute, spinescent, twisted (insertion not parallel to rachis); midrib raised above, raised below (less prominently). *Cataphylls* narrowly triangular, soft, pilose, 50–90 mm long. *Pollen cones* fusiform, green or cream, c. 40 cm long, 8 cm wide; microsporophyll lamina soft, not dorsiventrally thickened, 38–44 mm long, 19–25 mm wide, fertile zone 30–35 mm long, sterile apex 4–6 mm long, apical spine absent. *Megasporophylls* 16–17 cm long, brown-tomentose; ovules 2–4, glabrous; lamina orbicular, 70–110 mm long, 40–60 mm wide, deeply pectinate, with 15–32 soft lateral spines 25–32 mm long, 2 mm wide, apical spine distinct from lateral spines, 20–30 mm long, 10–25 mm wide at base. *Seeds* subglobose to ovoid, 35–40 mm long, 30–35 mm wide; sarcotesta yellow, not pruinose, 2 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Historical notes: described in 1975 by Chinese botanist C.J. Chen, from material collected by Y. Zhong Wangning County in 1961. This species was initially contrasted with *C. rumphii*, although we now know that its affinities are quite removed from the latter. Chinese flora accounts recorded this species from only Hainan, although later accounts (Zhou et al. 1990) noted that it was cultivated in Fujian, Guangdong and Sichuan. More recently, a proposal was made that at least the Guangdong plants were taxonomically distinct (Deng, cited by Walters et al. 1995). We now know that the Mainland plants are distinct, and that the type of *C. taiwaniana* belongs here (see discussion under that species).

Distinguishing features: *C. hainanensis* is very close to *C. taiwaniana*, differing in the more keeled leaves with narrower and more crowded leaflets, and the smaller megasporophyll lamina with fewer but longer lateral spines and an often greatly expanded apical spine. Seeds are also distinctly larger.

Distribution and habitat: known only from the wetter eastern parts of Hainan Island (Fig. 3). Wild populations are now very restricted, and this species survives mainly in cultivation. Plants occur from sea level to about 1200 m. elevation, on soils on limestone and volcanic substrates. Climate here is subtropical, and rainfall high (c. 2000 mm annually), and the usual habitat is rainforest.

Conservation status: Ver 3.1:IUCN (2001) status is **EN** (Donaldson 2003).

Selected specimens examined: CHINA: Hainan: Luilianling, Wangning County, *Tang 92586* (PE); southern Wanning County, *Yang NSW 271211*, 30 Oct 1992 (NSW); Qiongdong County, *Liang 68119* (IBSC n.v.); Baoting County, *Liang 68300* (IBSC n.v.); Mt Diaolou, Lingshui County, *Hainan Expedition*, 1959 (PE); Bawangling, Changjiang County, *Chen 92606* (PE). **Cult.:** cultivated at Pingxian Istitute of Forestry, Guangxi, *C.J. Chen, Y.C. Zhong & K.D. Hill 36, 37*, 22 Nov 1998 (NSW, FTG, NY, PE); Haiku Peoples Park, Haiku, Hainan, *Chun 17629* (IBSC n.v., PE).

14. *Cycas shanyaensis* G.A. Fu, Bull. Bot. Res. 26(1): 2-3, Fig. 1 (2006) as '*shanyagensis*'.

Type: China, Hainan, Sanya city, 15 Sep 2003, *G.A. Fu 11022* (holo HFB n.v.).

Etymology: from Shanya city/district in southern Hainan province, with the Latin termination -ensis, place of origin. Originally published as *Cycas shanyagensis* where the specific epithet has been formed incorrectly by the introduction of a superfluous letter 'g'. Also the use of 'shan' (meaning mountain) is not correct when the chinese character

used (三) means three and therefore should be 'san'. However, the apparently mistaken usage has been used consistently throughout the paper and is maintained here.

Stems arborescent, to 2.1–3.1 m tall, 20–25 cm diam. at narrowest point. *Leaves* 140–160 cm long, with 130–144 leaflets. Petiole 33 cm long (21–23% of total leaf), glabrous, spinescent for 76–82% of length, spines 2–3 mm long. *Median leaflets* simple, 115–240 mm long, 7–9 mm wide, slightly decurrent margins flat or slightly revolute. *Pollen cones* dark velvety brown conical-cylindric, c. 22 cm long, 3–8 cm wide; microsporophyll lamina, 15–22 mm long, 10–15 mm wide, apical spine mucronate. *Megasporophylls* 11.5–15 cm long, yellow-brown tomentose; ovules 4, glabrous; lamina obovate or flabelliform, 75 mm long, 75–90 mm wide, deeply pectinate, with 15–17 soft lateral spines 15–25 mm long, apical spine, 25–35 mm long to 4 mm wide, with 4–6 lateral spines 5–7 mm long.

Description based entirely on Fu (2006); no specimens have been sighted by Hill.

Historical notes: described in 2006 by Chinese botanist G.A. Fu.

Distinguishing features: *C. shauyaensis* is allied to *C. hainanensis*, differing in the presence of a toothed terminal spine on the megasporophyll and narrower apical spine on megasporophyll lamina.This taxon is accepted here on the basis of the protologue but requires further field study.

Distribution and habitat: known only from southern Hainan Island (Fig. 3). This species grows in mountain mixed forest 700 – 800 m alt.

Conservation status: recommended Ver 3.1:IUCN(2001) status would be **NE.**

Selected specimens (cited by G.A. Fu): CHINA: Hainan: Shan-Ya city, Baolong shan mountain mixed forest, 700-800 m alt., *G.A. Fu 11166, 11173*, 7 May 2004 (HFB n.v.)

15. *Cycas changjiangensis* N.Liu, Acta Phytotax. Sin. 36: 552 (1998).

Cycas hainanensis subsp. *changjiangensis* (N.Liu) N.Liu, Proc. Sixth Int. Conf. Cycad Biol.: 3 (2004).

Type: China, Hainan, Changjiang, 10 Jun 1997, *N. Liu 97002* (holo IBSC n.v.).

Etymology: from Changjiang county in western Hainan province, with the Latin termination -ensis, place of origin.

Stems acaulescent, to 20 cm diam. at narrowest point; 30–60 leaves in crown. *Leaves* bright green, highly glossy, 70–230 cm long, moderately keeled (opposing leaflets inserted at 120–160° on rachis), with 80–220 leaflets, with orange tomentum shedding as leaf expands; rachis usually terminated by paired leaflets; petiole 20–70 cm long (20–30% of total leaf), petiole glabrous, spinescent for 70–100% of length; basal leaflets not gradually reducing to spines, 70–140 mm long; spines 1–4 mm long. *Median leaflets* simple, strongly discolorous, 150–300 mm long, 6–10 mm wide, inserted at 40–70° to rachis, decurrent for 2–7 mm, narrowed to 2.5–3 mm at base (to 30–45% of maximum width), 8–15 mm apart on rachis, twisted (insertion not parallel to rachis); median leaflets section slightly keeled; margins slightly recurved; apex acute, spinescent; midrib raised above, raised below (less prominently). *Cataphylls* narrowly triangular, soft, pilose, 50–90 mm long. *Pollen cones* broadly fusiform, yellow–brown, 15–23 cm long, 4–6 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, 15–20 mm long, 5–9 mm wide, , apical spine rudimentary (measurements taken from

Liu 1998). *Megasporophylls* 16–17 cm long, brown-tomentose; ovules 2–4, glabrous; lamina orbicular, 70–110 mm long, 40–60 mm wide, deeply pectinate, with 15–32 soft lateral spines 25–32 mm long, 2 mm wide, apical spine distinct from lateral spines, 20–30 mm long, 10–25 mm wide at base. *Seeds* subglobose to ovoid, 35–40 mm long, 30–35 mm wide; sarcotesta yellow, not pruinose, 2 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Historical notes: described in 1998 by Chinese botanist N. Liu.

Distinguishing features: *C. changjiangensis* is allied to *C. hainanensis*, differing in the dwarf, largely subterranean habit and the smaller megasporophyll lamina and smaller seeds.

Distribution and habitat: known only from western Hainan Island (Fig. 3). This species grows in seasonally dry woodlands on deeper sandy soils on flatter country.

Conservation status: some quite large populations still exist in the wild, the natural habitat not being good agricultural land. Other populations are severely degraded, and the overall reduction in recent years indicates that this species should be regarded as threatened. IUCN status Ver 3.1:IUCN (2001) status is **EN** (Donaldson 2003).

Selected specimens examined: CHINA: Hainan: Bawangling, Changjiang County, *Chen 92606* (PE). **Cult.:** Nong Nooch Tropical Garden, Thailand (no voucher); Botanic Gardens, Sydney, Australia , seed from Liu 1996, *s.n,* coll. from Changjiang County, Hainan Isl. (NSW).

16. *Cycas bifida* (Dyer) K.D.Hill, Bot. Rev. 70(2): 161 (2004).

C. rumphii var. *bifida* Dyer, J. Linn. Soc., Bot. 26: 560 (1902).

Type: China, Guangxi, Lighthouse pagoda rockhills, Lungchow [Longzhou], *Morse 273*, Dec 1896 (holo K, 2 sheets).

Literature: Cheng et al. (1975, as *C. micholitzii*), Chen and Stevenson (1999, as *C. micholitzii*).

Illustrations: Wang (1996, as *C. micholitzii*).

Etymology: from the Latin *bi-* two and *-fidus* divided, referring to the dichotomously divided leaflets.

Vernacular: Chinese - *long-kou su-tie, cha-ye su-tie* (fork leafed cycad) (Walters & Yang 1994, Chen et al. 1995, Bonta & Osborne 2007).

Stems acaulescent, 10–30 cm diam. at narrowest point, 2–5 leaves in crown. *Leaves* bright green, semiglossy, 200–500 cm long, slightly keeled to flat in section (opposing leaflets inserted at 120–180° on rachis), with 40–80 leaflets, with white and orange tomentum shedding as leaf expands; rachis usually terminated by paired leaflets; petiole 110–160 cm long (35–50% of total leaf), glabrous, spinescent for 90–100% of length; basal leaflets not gradually reducing to spines; spines 1–6 mm long. *Median leaflets* dichotomously branched up to three times, strongly discolorous, 300–600 mm long, 18–25 mm wide, inserted at 45–70° to rachis, decurrent for 10–15 mm, narrowed to 3–4 mm at base (to 14–20% of maximum width), 60–95 mm apart on rachis; section flat; margins flat; apex softly acuminate, not spinescent; midrib raised above, flat below. *Cataphylls* narrowly triangular, soft, pilose, 55–90 mm long. *Pollen cones* fusiform, yellow or cream, 35–55 cm long, 6–8 cm diam.; microsporophyll lamina soft,

not dorsiventrally thickened, 17–28 mm long, 13–16 mm wide, fertile zone 14–25 mm long, sterile apex 2–3 mm long, level, apical spine absent. *Megasporophylls* 7–11 cm long, brown-tomentose; ovules 2–6, glabrous; lamina ovate, 35–100 mm long, 25–50 mm wide, deeply pectinate, with 12–15 soft lateral spines 18–50 mm long, 2–3 mm wide, apical spine distinct or not distinct from lateral spines, 15–70 mm long, 3–8 mm wide at base. *Seeds* flattened-ovoid, 25 mm long, 20 mm wide; sarcotesta yellow, not pruinose, 2 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Historical notes: this species was first recognized as a distinct taxon in western literature by English botanist Sir William Thiselton-Dyer in 1902, who described it as *C. rumphii* var. *bifida*, on the basis of a leaf fragment collected by H.B. Morse in the Longzhou district of southern Guangxi in 1896. Thiselton-Dyer later received material apparently collected by W. Micholitz in Annam (central Vietnam) from Sander & Sons in 1905, and from Henry Ridley of the Singapore Botanic Gardens at about the same time. He described this as a new species *C. micholitzii* in 1905, noting the similarities with the specimen he had earlier described as *C. rumphii* var. *bifida* but not combining the two. Subsequent authors have regarded them as the same species until recent studies have shown them to be distinct.

Distinguishing features: the most immediately striking feature of this species is the dichotomously divided leaflets. However, this also occurs in several related taxa, and in a horticultural form of *C. revoluta* that is popular in Japan. The subterranean habit, the small, soft microsporangiate cones, the loose, freely peeling sarcotesta lacking a fibrous layer and the verrucose sclerotesta are also all features shared by a wider group of related species (Section *Stangerioides*). Within this group of related species, *C. bifida* is distinguished by the long leaves with glossy, thin-textured, comparatively long and broad leaflets that are dichotomously divided very near to the base. It is most similar to *C. micholitzii* from central Vietnam, and can be distinguished by the larger stature, longer, broader, more lax and glossier leaflets and the larger microsporangiate cones with mostly non-spinescent microsporophylls.

Distribution and habitat: Southern Guangxi Province in China and north-eastern Vietnam (Fig. 4). Locally abundant but many populations are now depleted, in low, scrubby but fairly dense mixed evergreen and deciduous or bamboo woodland, often on red *terra rosa* soils on and around steep karst limestone outcrops, but also on loamy soils over shales and metasandstones. This species is apparently sympatric with *C. multipinnata* in several populations in China, and a range of morphologically intermediate forms that can be interpreted as a hybrid swarm has been observed (see *C. longipetiolula* and *C. multifroudis*, excluded names, below).

Conservation: this species has been severely reduced in numbers both by collecting and by unrestrained agricultural and forestry development. The rarity combined with the unusual habit make it a very highly sought plant by collectors. It is still, however, frequent in many places, especially in Vietnam, and not considered to be at risk in the short term. Treated in the 1997 IUCN Red List as *C. micholitzii* status E for China. Ver 3.1:IUCN (2001) status is **VU** (Donaldson 2003).

Selected specimens examined: CHINA: Guangxi: cult., nursery of Nanning Forestry Research Centre, Nanning, coll. Longzhou County, 7 Nov 1998, *Chen, Zhong & Hill 3* (NSW, PE); cult. Longzhou city park, coll. Longzhou County, 21 Nov 1998, *Chen, Zhong & Hill 35* (NSW, PE). **Yunnan:** Hekou county, *Hong 347, Chen, Hill & Stevenson*, 6 Jul 2000 (YUN, PE). **VIETNAM: Lang Son:** Trang Dinh, Chi Lang, Keo Quang, 13 Mar 1999, *Hill 5027, Loc & Dzu* (HN, NSW);

Binh Gia, Thien Hoa, Thien Thua, 28 Mar 1996, *Yang & Hiep SLY764* (HN). **Cao Bang:** Thach An, Duc Xuan, Tuc Nga, 13 Mar 1999, *Hill 5028, 5030 & Loc* (HN, NSW); Thach An, Tong Con, 3 Dec 1996, *Loc et al. CBL853* (HN). **Tuyen Quang:** Son Duong, Hop Thanh, Dong Dai, *Hiep 4116 & Hill*, 15 Jan 2000 (HN, NSW); Yen Son, Tien Bo, Goc Thi Cult in garden, coll from wooded hills in general vicinity, 17 Mar 1999, *Hill 5047 & Loc* (HN, NSW).

Hybrids: ***Cycas bifida* X *C. multipinnata*: CHINA: Yunnan:** Gejiu county, Yuanjiang River valley, *D.Y. Wang & H. Peng 5523*, 23 Apr 1994 (SZG; holotype of *C. longipetiolula*). Hekou county, Lianhuatang to Makayih, on the border of Hekou and Gejue(Manhao) *Chen, Hong, Hill & Stevenson 011 (Hong 350)*, 6 Jul 2000 (PE, YAF, IBSC, NSW, NY). ***Cycas bifida* X *C. dolichophylla*: VIETNAM: Thai Nguyen:** 15 km NW of Thai Nguyen city - sight record, no voucher, *Nguyen & Hill*, 17 Jan 2000.

17. *Cycas multipinnata* C.J.Chen & S.Y.Yang, Acta Phytotax. Sin. 32(3): 239 (1994). *Epicycas multipinnata* (C.J.Chen & S.Y.Yang) de Laub., in De Laub. & Adema, Blumea 43: 391 (1998).

Type: China, Yunnan, S. Jianshui County, near Red River, 1100 m, Apr 1987, *S.Y. Yang 9202* (holo PE).

Literature: Wang (1996), Chen and Stevenson (1999).

Illustrations: Wang (1996).

Etymology: from the Latin *pinnatus*, pinnate, with the compound prefix *multi-*, many, referring to the complexly branched leaflets.

Vernacular: Chinese - *duoqi su-tie* (multipinnate cycad), *dnjuetie* (single leaf cycad) (Chen et al. 1995, Bonta & Osborne 2007).

Stems acaulescent, 14–25 cm diam. at narrowest point, 1–2 leaves in crown. *Leaves* deep green, highly glossy, 200–600 cm long, slightly keeled (opposing leaflets inserted at 120–150° on rachis), bipinnate, with 14–36 leaflets, with white tomentum shedding as leaf expands; rachis consistently terminated by paired leaflets; petiole 100–350 cm long (50–65% of total leaf), glabrous, spinescent for 90–100% of length; basal leaflets not gradually reducing to spines, 500–720 mm long; spines 1–6 mm long. *Median leaflets* pinnately divided, strongly discolorous, 400–600 mm long, 12–22 mm wide, inserted at 45–70° to rachis, not decurrent, narrowed to 1–3 mm at base (to 8–14% of maximum width), 160–200 mm apart on rachis, pinnules dichotomously branched, segments 15–22 mm wide; section flat; margins flat; apex softly acuminate, not spinescent; midrib raised above, flat below. *Cataphylls* narrowly triangular, soft, pilose, 40–60 mm long. *Pollen cones* fusiform, cream, 25–40 cm long, 6–8 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, apex level or raised, apical spine absent. *Megasporophylls* 11–13 cm long, brown-tomentose; ovules 2–6, glabrous; lamina ovate, 60–70 mm long, 50–60 mm wide, deeply pectinate, with 20–22 soft lateral spines 30–40 mm long, 1.5–2 mm wide, apical spine distinct or not distinct from lateral spines, 30–40 mm long, 3–4 mm wide at base. *Seeds* flattened-ovoid, 25 mm long, 21 mm wide; sarcotesta yellow, not pruinose, 2 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Historical notes: although known for several decades, this remarkable species was only recognised as distinct and published in 1994 by Chinese botanist C.J. Chen.

Distinguishing features: the bipinnate leaves immediately distinguish this species and the closely related *C. debaoensis* within the genus. *C. multipinnata* is distinguished from

the latter by the longer leaves with broader, thinner leaflets that are broadest above the mid-point, and the smaller megasporophylls with a smaller apical lamina. The subterranean habit, the small, soft microsporangiate cones, the loose, freely peeling sarcotesta lacking a fibrous layer and the verrucose sclerotesta are features shared by a wider group of related species (Section *Stangerioides*).

Distribution and habitat: known from several quite widely disjunct populations, a limited area in the Red River gorge in eastern Yunnan, with a disjunct occurrence in Yen Bai Province, northern Vietnam aand another in western Guangxi in China (Fig. 4). In all occurrences it is found growing in closed evergreen forest on limestone on very steep slopes. Much of the forest habitat has been cleared or severely degraded. Putative hybrids with *C. bifida* are discussed above.

Conservation status: this species is already severely depleted in the Chinese population on the Red River and potentially at risk from horticultural collectors. It is regarded as endangered, although further study of the Vietnamese and Guanxi occurrences is essential. Ver 3.1:IUCN (2001) status is **EN** (Donaldson 2003).

Selected specimens examined: VIETNAM: Yen Bai: Yen Binh, Phuc Ninh, village no. 4, Chang Re mountain, *Hiep 4113 & Hill*, 14 Jan 2000 (HN, NSW). **CHINA: Yunnan:** Gejiu county, Manhao, *Lindstrom s.n.* (NSW, HN); Hekou county, Lianhuatang to Makayihe, on the border of Hekou and Gejue (Manhao), *Chen, Hong, Hill & Stevenson 9, 10 (Hong 348, 349)*, 6 Jul 2000 (PE, YAF, IBSC, NSW, NY);

18. *Cycas debaoensis* Y.C.Zhong & C.J.Chen, Acta Phytotax. Sin. 35(6): 571 (1997).

Type: China, Guangxi, Debao, 106°14'E 23°30'N, 27 Aug 1997, Y.C. Zhong 8762 (holo PE, iso GXF).

Etymology: from the county of Debao in western Guangxi province, with the Latin termination -ensis, place of origin.

Stems acaulescent, 15–20 cm diam. at narrowest point; 3–15 leaves in crown. *Leaves* deep green, semiglossy, 250–300 cm long, moderately keeled (opposing leaflets inserted at 80° on rachis), with 30–50 leaflets, with white tomentum shedding as leaf expands; rachis consistently terminated by paired leaflets; petiole 80–150 cm long (30–50% of total leaf), petiole glabrous, spinescent for 100% of length; basal leaflets not gradually reducing to spines, 130–170 mm long; spines 1–4 mm long. *Median leaflets* pinnately divided, then dichotomously branched towards the tip, strongly discolorous, 500–560 mm long, 7–11 mm wide, inserted at 75–80° to rachis, not decurrent, narrowed to 2–3 mm at base, (to 27–29% of maximum width), 40 mm apart on rachis, inserted parallel to rachis; section flat; margins flat; apex acute, not spinescent; midrib raised above, flat below. *Cataphylls* narrowly triangular, soft, pilose, 70–90 mm long. *Pollen cones* fusiform, cream, 20–30 cm long, 5–7 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, apex level or raised, apical spine absent. *Megasporophylls* 12–14 cm long, brown-tomentose; ovules 2–6, glabrous; lamina orbicular or ovate, 80–90 mm long, 80–90 mm wide, deeply pectinate, with 26–28 soft lateral spines 40–50 mm long, 2 mm wide, apical spine distinct or not distinct from lateral spines, 30–40 mm long, 3–4 mm wide at base. *Seeds* ovoid, 25–27 mm long, 20–22 mm wide; sarcotesta yellow, not pruinose, 2 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Historical notes: this remarkable species was only discovered in 1996 and described in

1997 by Chinese botanists C.J. Chen and Y.C. Zhong.

Distinguishing features: the bipinnate leaves immediately distinguish this species and the closely related *C. multipinnata* within the genus. *C. debaoensis* is distinguished from the latter by the shorter and more numerous leaves with narrower, thicker leaflets that are broadest below the mid-point, and the usually longer megasporophylls with a larger lamina. The subterranean habit, the small, soft microsporangiate cones, the loose, freely peeling sarcotesta lacking a fibrous layer and the verrucose sclerotesta are features shared by a wider group of related species (Section *Stangerioides*).

Distribution and habitat: known from two populations in a limited area Debao and Napo Counties in western Guangxi (Fig. 4), growing in mixed evergreen and deciduous woodland on limestone on slopes. Most of the forest habitat has been cleared or severely degraded.

Conservation status: this species is already severely depleted, and potentially at risk from horticultural collectors. It is regarded as critically endangered. Ver 3.1:IUCN (2001) status is **CR** (Donaldson 2003).

Selected specimens examined: CHINA: Guangxi: Debao county, Guangxi province,

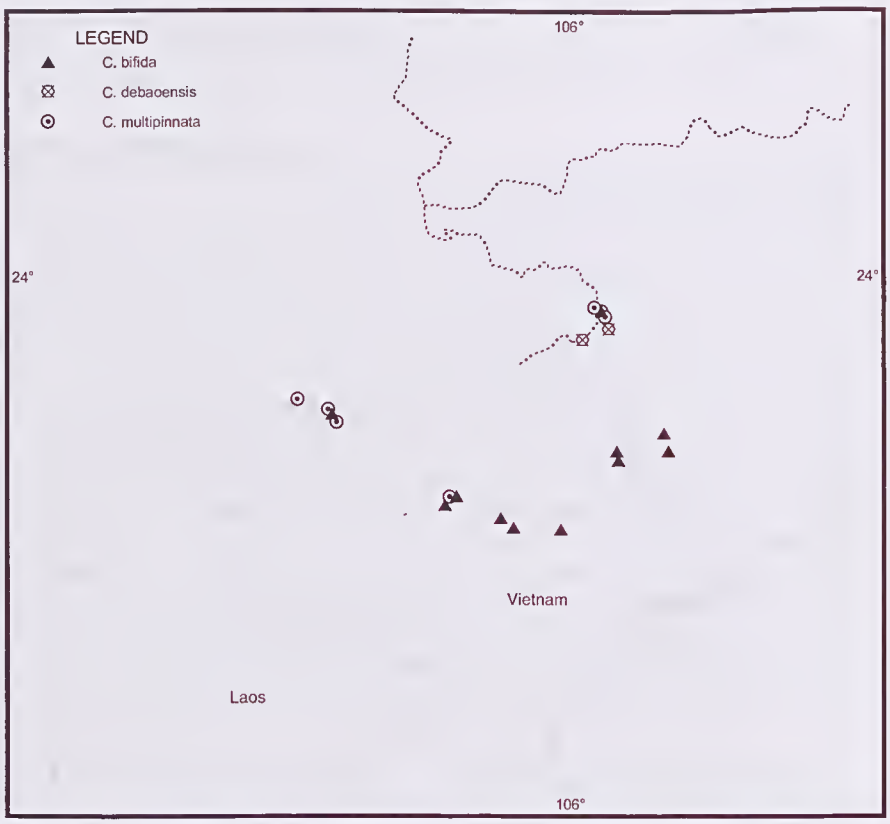

Fig. 4. Distributions of *Cycas debaoensis, C. bifida* and *C. multipinnata.*

Chen, Zhong & Hill 06, 8 Nov 1998 (NSW, BM, FTG, HN, K, KL, L, MO, NY, P, PE)

19. *Cycas ferruginea* F.N.Wei, Guihaia 14: 300 (1994)

Type: cultivated, Guilin Botanical Garden, thought to be introduced from Longzhou County, Guanxi, China, *F.N. Wei 2220*, 31 Aug. 1994 (holo IBK).

Literature: Wang (1996, as *C. miquelii*); Chen and Stevenson (1999).

Illustrations: Wei (1994).

Etymology: from the Latin *ferruginea* rusty red, from the abundant deep red tomentum on new growth and persisting to some extent on the older leaves.

Stems arborescent or acaulescent, to 1.2 m tall, 12–18 cm diam. at narrowest point, 10–25 leaves in crown. *Leaves* deep green or grey-green, highly glossy or semiglossy, 130–210 cm long, slightly keeled or flat (not keeled) in section (opposing leaflets inserted at 150–180° on rachis), with 120–200 leaflets, with white or orange or brown tomentum shedding as leaf expands or persistent below; rachis usually terminated by paired leaflets; petiole 35–80 cm long (25–40% of total leaf), glabrous or pubescent, spinescent for 30–100% of length; basal leaflets not gradually reducing to spines, 80–190 mm long; spines 1–3 mm long. *Median leaflets* simple (often falcate), strongly discolorous, 190–380 mm long, 8–13 mm wide, inserted at 70–90° to rachis, decurrent for 4–8 mm, narrowed to 2.5–4 mm at base (to 25–40% of maximum width), 10–19 mm apart on rachis, inserted parallel to rachis; section slightly keeled; margins recurved; apex acute, spinescent; midrib raised above, flat below. *Cataphylls* narrowly triangular, pungent, pilose, 90–120 mm long. *Pollen cones* fusiform, orange, 25–45 cm long, 4–6 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, 16–20 mm long, 9–13 mm wide, fertile zone 15–18 mm long, sterile apex 3–5 mm long, raised, apical spine rudimentary, sharply upturned, 0–3 mm long, or absent. *Megasporophylls* 11–19 cm long, brown-tomentose; ovules 2–6, glabrous; lamina orbicular, 70–110 mm long, 50–80 mm wide, deeply pectinate, with 28–42 soft lateral spines 18–40 mm long, 1–3 mm wide, apical spine distinct from lateral spines, 15–50 mm long, 3–8 mm wide at base. *Seeds* ovoid, 19–24 mm long, 15–21 mm wide; sarcotesta yellow, not pruinose, 1–2 mm thick; fibrous layer absent; sclerotesta verrucose; spongy endocarp absent.

Historical notes: described by Chinese botanist Wei Fan-Nan in 1994, from a single plant in cultivation in Guilin. The wild source was not known at the time, making the origin something of a mystery. Field studies in Vietnam in 1997 discovered large populations of a cycad that appears to match the type plant in Lang Son province. Wild plants have also since been discovered in Tiandong County, western Guangxi Province in China.

Distinguishing features: closely allied to *C. sexseminifera*, but immediately distinguished by the dense dark ferruginous tomentum on new growth, the longer leaves and the longer often falcate leaflets with recurved margins. It also differs in the generally larger proportions in all respects, and the larger and broader megasporophyll lamina. The small, soft microsporangiate cones, the loose, freely peeling sarcotesta lacking a fibrous layer and the verrucose sclerotesta are features shared by a wider group of related species (Section *Stangerioides*).

Distribution and habitat: a restricted species, known from limestone bluffs in western Guangxi Province in China, and also in Lang Son and Thai Nguyen provinces in

Vietnam (Fig. 5). This species shows the same habitat preference as *C. sexseminifera* and *C. tropophylla*, growing on bare limestone faces on steep limestone bluffs, with no visible soil at the roots.

Conservation status: Ver 3.1:IUCN (2001) status is NT (Donaldson 2003).

Selected specimens examined: CHINA: Guangxi: cultivated, Guilin Institute of Botany (type plant), 28 Nov 1998, *Chen, Zhong & Hill 43* (NSW, PE); Tiandong county, Zuodeng town, 280 m, rocky crevices in limestone mountain, *Chen & Li T2001 – 01, 02, 03*, 26 Apr 2001 (PE, NSW, NY, SZG); *Zhong s.n.*, 2 Feb 1999 (PE, NSW, NY). **VIETNAM: Lang Son:** Huu Lien Nature Reserve, near border post, Huu Lung district, 10 May 1998, *Hill 4995, 4996, 4997*, 4998 & Loc (NSW, HN K NY PE BKF L P MO CANB); Huu Lien Nature Reserve, near village, Huu Lung district, 11 May 1998, *Hill 5000, 5001, 5002 & Loc* (NSW, HN K NY PE BKF L P MO CANB); Huu Lung, Huu Lien, Apr 1998, *Hiep 2410, 2411, 2412* (HN). **Thai Nguyen:** Dong Hy, Quang Son cult in garden, coll from steep limestone cliffs 3–400 m to W, 16 Mar 1999, *Hill 5043 5044 & Loc* (HN, NSW); Vo Nhai, La Hien, 20 km NE of Thai Nguyen city, 28 Mar 1996, *Yang & Hiep 766* (HN).

20. *Cycas sexseminifera* F.N.Wei, Guihaia 16: 1 (1996).

Type: cultivated, Guilin Botanical Garden, introduced from Longzhou County, Guangxi, China, *F.N. Wei 2223*, 1994 (holo IBK).

Cycas acuminatissima Hung T.Chang, Y.C.Zhong & Z.F.Lu, Acta Sci. Nat. Univ. Sunyatseni 37(4): 6 (1998).

Type: China, Guangxi, Tianyang, *Y.C. Zhong 8770*, 26 Mar 1998 (holo SYS n.v.). Included in the synonymy of *C. segmentifida* by Chen and Stevennson (1999), but the type collection is from within the range of *C. sexseminifera* and away from the range of *C. segmentifida*. The illustration accompanying the protologue also matches *C. sexseminifera*, and this taxon is here included in the synonymy of that species. Field studies in the type locality also do not substantiate the presence of another taxon.

Cycas brevipinnata Hung T.Chang, Y.Yuan Huang &Y.C.Zhong, Acta Sci. Nat. Univ. Sunyatseni 37(4): 8 (1998).

Type: cultivated Nanning arboretum Guangxi, China, *H.X. Zheng & Y.Y. Huang 98003*, 21 Apr 1998 (holo SYS n.v.). Included in the synonymy of their concept of *C. miquelii* by Chen and Stevenson (1999), and in *C. sexseminifera* by Chen and Liu (2004).

Cycas longisporophylla F.N.Wei, Guihaia 17: 209 (1997).

Type: cultivated, Guilin Botanical Garden, introduced from Longzhou County, Guangxi, China, *F.N. Wei 2222*, 19 Jun 1995 (holo IBK). Included in the synonymy of their concept of *C. miquelii* by Chen and Stevenson (1999), and in *C. sexseminifera* by Chen and Liu (2004).

Cycas septemsperma Hung T.Chang, Y.Yuan Huang & H.X.Zheng, Acta Sci. Nat. Univ. Sunyatseni 37(4): 8 (1998).

Type: cultivated Nanning arboretum Guangxi, China, *Y.Y. Huang & H.X. Zheng 192*, Aug 1998 (holo SYS n.v.). Included in the synonymy of their concept of *C. miquelii* by Chen and Stevenson (1999), and in *C. sexseminifera* by Chen and Liu (2004).

Cycas spiniformis J.Y.Liang, in F.N.Wei, Guihaia 17: 211 (1997).

Type: cultivated, Guilin Botanical Garden, introduced from Longzhou County, Guangxi, *F.N. Wei 2266*, 16 Sep 1995 (holo IBK). Included in the synonymy of their

concept of *C. miquelii* by Chen and Stevenson (1999), and in *C. sexseminifera* by Chen and Liu (2004).

Cycas crassipes Hung T.Chang, Y.C.Zhong & Z.F.Lu, Acta Sci. Nat. Univ. Sunyatseni 38(3): 121–122 (1999).

Type: Guangxi, Longling County, *Y.C. Zhong 8778*, 29 May 1998 (holo SYS n.v.). The type collection is from within the range of *C. sexseminifera*. The illustration accompanying the protologue matches *C. sexseminifera*, and this taxon is here included in the synonymy of that species. Field studies in the type locality also do not substantiate the presence of another taxon.

Cycas miquelii non Warb., sensu Wang (1996), De Laubenfels and Adema (1998, in part), Chen and Stevenson (1999), see below.

Literature: Wang (1996, as *C. miquelii)*, Chen and Stevenson (1999, as *C. miquelii*).

Illustrations: Wang (1996, as *C. miquelii*).

Etymology: from the latin *sex*, six, and *seminifera*, seed-bearing, in the misplaced belief that the six seeds observed on the megasporophyll of the type plant was a diagnostic distinction.

Stems arborescent or acaulescent, to 0–1 m tall, 8–20 cm diam., 4–20 leaves in crown. *Leaves* deep green, semiglossy, slightly keeled to flat (not keeled) in section (opposing leaflets inserted at 150–180° on rachis), with 80–200 leaflets 50–120 cm long, with brown tomentum shedding as leaf expands;rachis consistently terminated by paired leaflets petiole 10–40 cm long (20–35% of total leaf), glabrous, unarmed or spinescent for 5–100% of length; basal leaflets not gradually reducing to spines, 10–80 mm long; spines 1–3 mm long. *Median leaflets* simple, strongly discolorous, 130–240 mm long, 6–10 mm wide, inserted at 70–85° to rachis, decurrent for 2–6 mm, narrowed to 2–5.5 mm at base (to 25–55% of maximum width), 8–14 mm apart on rachis, section slightly keeled, margins flat or slightly recurved; apex aristate, spinescent; midrib raised above, raised below. *Cataphylls* narrowly triangular, soft, pilose, 30–50 mm long. *Pollen cones* narrowly ovoid to fusiform, yellow, 15–30 cm long, 5–8 cm diam.; microsporophyll lamina soft, not dorsiventrally thickened, 20–30 mm long, 12–30 mm wide, fertile zone 10–28 mm long, sterile apex 2–4 mm long, raised, apical spine rudimentary or absent, sharply upturned, 0–3 mm long. *Megasporophylls* 8–12 cm long, brown-tomentose; ovules 2–6, glabrous; lamina orbicular, 35–55 mm long, 30–50 mm wide, deeply pectinate, with 16–28 soft lateral spines 10–25 mm long; apical spine distinct from lateral spines, 30–40 mm long. *Seeds* ovoid, 20–28 mm long, 18–25 mm wide; sarcotesta yellow, not pruinose; fibrous layer absent; sclerotesta smooth to verrucose; spongy layer absent.

Historical notes: Metcalf (1942) applied the name *C. inermis* to this species. Later treatments from China (Cheng et al. 1975, Zhou et al. 1990) also confused it with *C. pectinata* (which does occur in China, but considerably to the west of this species). Occurrences in Vietnam were overlooked by Leandri (1931), Ho (1960, 1991) and Hiep and Vidal (1996). Wang (1996) and Chen and Stevenson (1999) applied the name *C. miquelii* to this species (see above under *C. revoluta* for extra comment on *C. miquelii*). The treatment under the name *C. miquelii* by de Laubenfels and Adema (1998) presents a confused concept that includes *C. sexseminifera* and other taxa. Their neotypification of the name *C. miquelii* is based on a specimen of a quite different species, *C. clivicola* from southern Thailand.

Distinguishing features: this species is most readily distinguished by the dwarf habit with a short stem and short, flat leaves with short, narrow, flat, rather stiff and pungent leaflets, and the small but broad megasporophyll lamina with a broad apical spine distinct from the lateral spines; petioles are often unarmed (hence the misapplication of the epithet "inermis"), but this character is not at all consistent. The small, soft microsporangiate cones, the loose, freely peeling sarcotesta lacking a fibrous layer and the verrucose sclerotesta are features shared by a wider group of related species (Section *Stangerioides*).

Distribution and habitat: widespread in southern and central Guangxi province of China, and in a limited area in Cao Bang province in central northern Vietnam in the border region with Guangxi, with a disjunct occurrence in Thanh Hoa province south of Hanoi (Fig. 5). Locally abundant, growing in crevices in bare outcrops in rugged karst limestone country, often on vertical faces with no visible soil.

Conservation status: although there is a clear demand for this species in horticultural markets in China and Vietnam, and a substantial collection from the wild for this trade, this species is extremely abundant in many inaccessible sites. Ver 3.1:IUCN (2001) status is **NT** (Donaldson 2003).

Selected specimens examined: CHINA: Guangxi: Longzhou county, Long Gan natural reserve, 21 Nov 1998, *Chen, Zhong & Hill 31, 32* (NSW, PE), *Chen, Zhong & Hill 33* (NSW, PE); cult., nursery of Nanning Forestry Research Centre, Nanning, collected from southern Guangxi (same collection as type plant of *Cycas brevipinnata*, separate plant), 7 Nov 1998, *Chen, Zhong & Hill 2* (NSW, P, PE); cult. Qing Xui Wu park, Nanning, collected from southern Guangxi, 7 Nov 1998, *Chen, Zhong & Hill 5* (NSW, PE); cult. Longzhou city park, collected nearby, 21 Nov 1998, *Chen, Zhong & Hill 34, 35* (NSW, PE). **VIETNAM: Cao Bang:** Thach An, Thuy Hung, 1 Dec 1996, *Averyanov et al. CBL912* (HN), 4 Dec 1996, *Averyanov et al. CBL878* (HN); Quang Hoa, Quoc Phong, Lung Trang, 14 Mar 1999, *Hill 5031 & Loc* (HN, NSW). **Ninh Binh:** Nho Quan, Cuc Phuong, Nga village, outside entrance to Cuc Phuong National Park, cult in garden, coll. on hill behind village, 19 Mar 1999, *Hill 5053 & Loc* (HN, NSW); Bich Dong, 25 Oct 1994, *Yang & Hiep SLY526* (HN). **Thanh Hoa:** Nhu Xuan, Ben En National Park, 21 Oct 1996, *Hiep 2114* (HN), 30 Mar 1996, *Loc P7063* (HN).

D. Section **INDOSINENSES** J.Schust.

Cycas section *Indosinenses* J.Schust., Pflanzenr. 99: 65 (1932).

Lectotype (fide Hill & Yang 1998): *C. siamensis* Miq. This is one of only two species included in this section by Schuster, and the single species remaining when the other species (*C. micholitzii*) is removed to section *Stangerioides*, as was done by Smitinand (1971).

Section *Indosinenses* is defined by the combination of stiff or woody male cones, glabrous ovules, a large, deeply pectinate megasporophyll lamina, and the presence of a layer of fibrous tissue within the sarcotesta. It is a taxonomically complex group ranging from Himalayan India and Nepal east to Vietnam and southern China and south to northern peninsular Malaysia. Sectional circumscription herein follows Wang (1996). Two species occur in China (Figs. 1, 6).

21. *Cycas pectinata* Buch.-Ham., Mem. Wern. Nat. Hist. Soc. 5(2): 322–323 (1826). *Cycas circinalis* subsp. *vera* var. *pectinata* (Griff.) Schuster, Pflanzenr. 99: 68 (1932).

Neotype: India, E. Bengal, Chittagong, *J.D. Hooker & Thompson 6*, 1855 (K: isoneo P).

De Laubenfels and Adema (1998) designated this specimen as lectotype but this was an error since the specimen was collected after the name was published. This error is correctible under ICBN Art. 9.8 and they are deemed to have neotypified it.

Cycas jenkinsiana Griff., Not. Pl. Asiat. 4: 9–10, Plates 360, fig. 1–2 and 362, fig. 1 (1854).

Type: India, Assam, *Jenkins s.n.* (holo K; iso BM, L). Included in the synonymy of *C. pectinata* by Smitinand (1971).

Literature: Chen and Stevenson (1999).

Illustrations: Smitinand (1971), Cheng et al. (1975), Grierson and Long (1983), Wang (1996), Tang et al. (1997), Hill and Yang (1998).

Etymology: from the Latin *pectina*, a comb, in reference to the long, comb-like teeth of the megasporophylls.

Vernacular: Assam - *thaljimura*; Burmese - *môndaing*; Chinese - *bi-chi su-tie* (cycad with comb-like megasporophylls), *feng-wei-jiao* (Phoenix-tail grass or palm), *feng-huang-dan*, Khasi - *dieng-sia-goda*; Nepalese - *thakal, thaljimura*; Thai - *boka, plong, prong khao, prong pa* (forest or field cycad) (Chen et al. 1995, Hill & Vatcharakorn 1998,

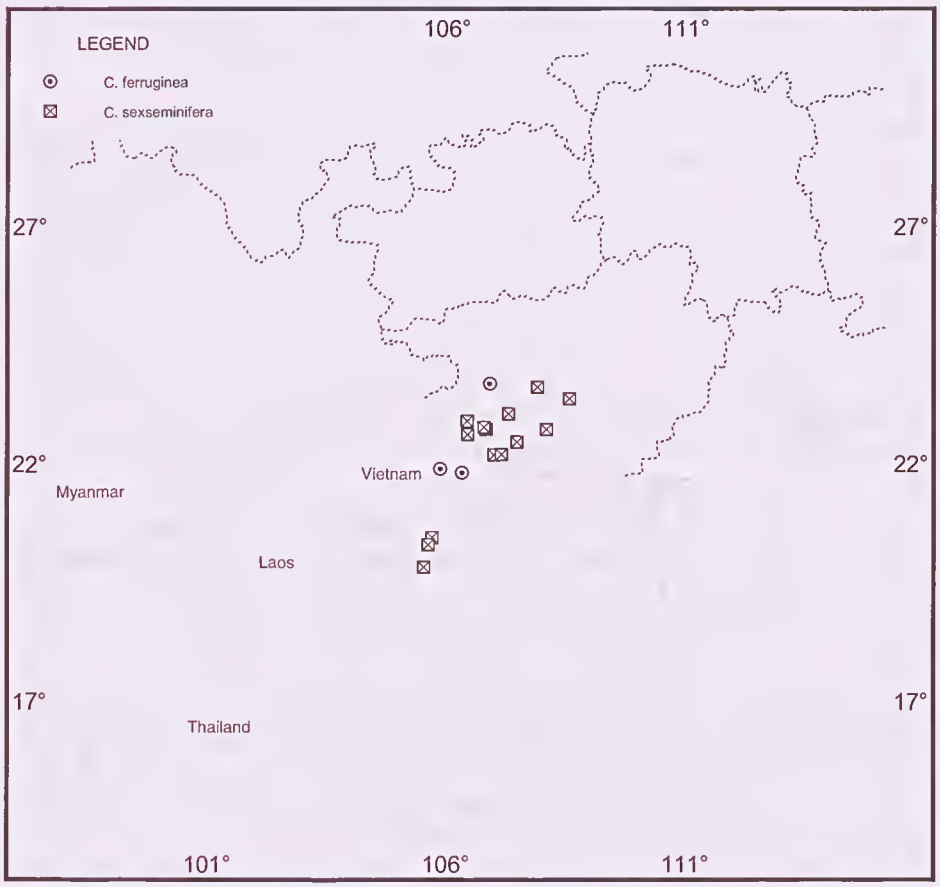

Fig. 5. Distributions of *Cycas sexseminifera* and *C. ferruginea.*

Pant 1962, Pant et al. 1994, Smitinand 1972, Walters & Yang 1994, Bonta & Osborne 2007).

Stems arborescent, to 1–12 m tall, 14–20 cm diam., 30–40 leaves in crown. *Leaves* deep green to grey-green, semiglossy, 150–240 cm long, with white tomentum shedding as leaf expands, flat (not keeled) in section (opposing leaflets inserted at 170–180° on rachis), with 180–312 leaflets, rachis consistently terminated by a spine 1–46 mm long; petiole 30–80 cm long (25–50% of total leaf), glabrous, spinescent for 30–80% of length; basal leaflets not gradually reducing to spines, 50–160 mm long; spines 1–4 mm long. *Median leaflets* simple, strongly discolorous, 200–315 mm long, 7.5–10.5 mm wide, inserted at 45–60° to rachis, decurrent for 4–8 mm, narrowed to 2.5–4 mm at base (to 35–45% of maximum width), 8–13 mm apart on rachis, section flat, margins slightly recurved; apex acute, spinescent to not spinescent; midrib raised above, raised below. *Cataphylls* narrowly triangular, soft, pilose. *Pollen cones* ovoid, yellow or green, 30–55 cm long, 16–22 cm diam.; microsporophyll lamina firm, not dorsiventrally thickened, 43–60 mm long, 19–24 mm wide, fertile zone 35–57 mm long, sterile apex 3–8 mm long, level, apical spine prominent, sharply upturned, 17–32 mm long. *Megasporophylls* 22–30 cm long, grey-tomentose; ovules 2–4, glabrous; lamina orbicular, 110–180 mm long, 100–130 mm wide, deeply pectinate, with 40–50 soft lateral spines 26–75 mm long, 2–3 mm wide; apical spine distinct from lateral spines, 35–75 mm long, 5–12 mm wide at base. *Seeds* flattened-ovoid, 42–45 mm long, 33–45 mm wide; sarcotesta yellow, not pruinose, 4–7 mm thick; fibrous layer present; sclerotesta smooth; spongy layer absent.

Historical notes: *C. pectinata* was the fourth species of *Cycas* to be named, described in 1826 by Scottish surgeon and botanist Francis Buchanan-Hamilton. No type was cited, but reference was made to occurrence in 'the hills which bound Bengal to the east', and the description cited 'Habitat in Camrupae orientalis sylvis'. *C. angulata* R. Brown and *Olus calappoides* of Rumphius (*C. rumphii*) were cited (erroneously) in synonymy. Zhou et al. (1990) regarded Hamilton's publication as illegitimate because *C. angulata* was cited as a synonym. The latter was cited, but with a question mark, indicating that the author was unsure of the placement of *C. angulata*. This does not invalidate Hamilton's publication (ICBN Art. 52.2, Note 1, Ex. 12). The primary set of Hamilton's Bengal collections eventually went to Wallich and thence to Kew (K-W). A second set went to E. Neither set includes a specimen that could be regarded as the type of *C. pectinata*.

The name *C. pectinata* has been incorrectly attributed to Griffith (1854) by numerous authors eg. Miquel (1868), Thistleton-Dyer (1888), Warburg 1900, Smitinand (1972), de Laubenfels (1988), but he was only giving a description of the species, not formally describing it. Griffith did not add his name to the binomial, which was his usual practice with existing or previously published names.

Distinguishing features: the very large, ovoid microsporangiate cones with long, narrow microsporophylls, those with long apical spines, readily distinguish this species from others in the *C. pectinata* group. The thin, smooth bark also distinguishes this species from related taxa, although this feature is shared with *C. clivicola* and *C. elongata*, and seems to be an artifact of the occurrence in wetter forests, where the usual armour of leaf bases and cataphylls is quickly removed by the general processes of decomposion in the moister environment.

Distribution and habitat: common and widespread in forest on hills of the central highlands, mostly above about 500 m altitude (Fig. 6). This species occurs in medium to tall forest on deep, often clay-rich and more fertile soils, usually as part of the general shrub understorey at medium to higher elevations in generally moist conditions in moderate to deep shade. Although often found on limestone substrates, it is by no means restricted to these, and also occurs on granites and metasediments.

C. pectinata is abundant in the hill forests in parts of north-eastern India, and has also been collected from Nepal and Bhutan. It extends into Yunnan Province in southern China, often on soil over limestone, and east into Thailand, Laos and Vietnam.

Conservation status: a very widespread species. Although its habitat is continually being reduced, large populations remain, and it is not under any immediate threat of extinction. Ver 3.1:IUCN (2001) status is **VU** (Donaldson 2003). The status is determined on the basis of the continuing population decline, although the very large populations remaining indicate that the short-term threat of extinction is low.

Selected specimens examined: CHINA: Yunnan, *Henry 13637* (K, NY); Meng Yuan district, Meng La Natural Reserve, *Lindstrom s.n.*, 1994 (no voucher); Simao County, *Mao Pymao 6109*, 20 Sep 1955 (KUN); Jinghong County, Na Bai, *Tao 43719*, 21 Oct 1988 (XBG). **BANGLADESH:** Chittagong, *Hooker & Thompson Herb. Ind. Or* (BM, K, L); Satakoina, Chittagong, *Hooker & Thompson 595*, 11 Jan 1857 (K). **BHUTAN:** E bank of Dangme Chu, between Cha Zam and

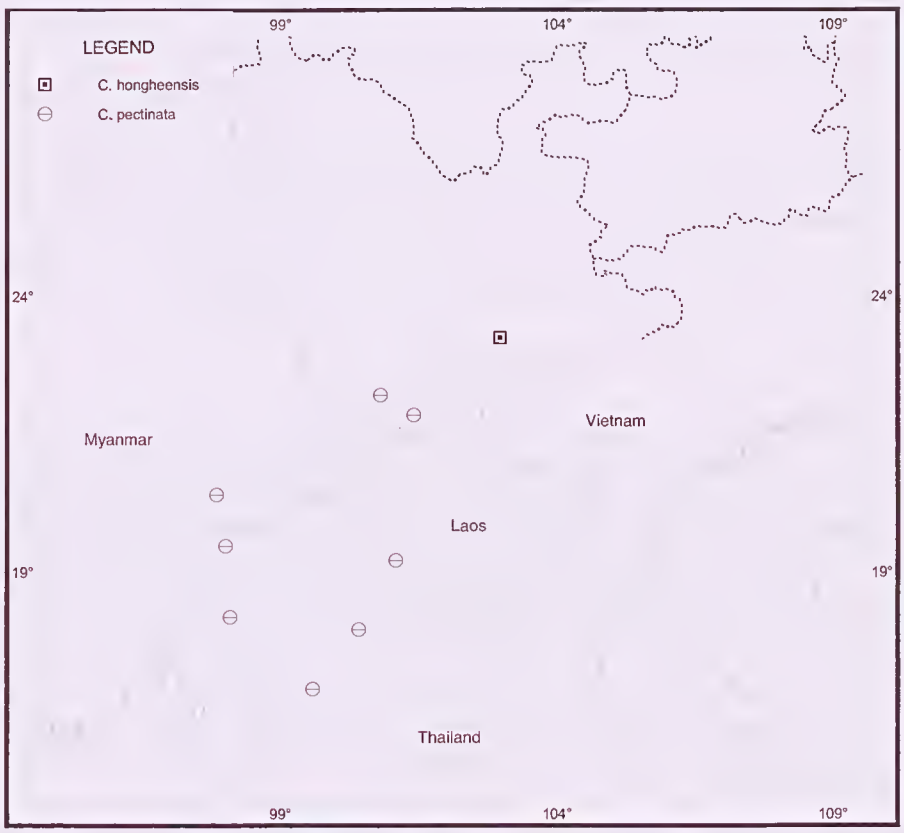

Fig. 6. Distributions of *Cycas pectinata* and *C. hongheensis*.

Duksun, N of Tashigang, *Grierson & Long 2357*, 29 Jun 1979 (K ex E). **INDIA:** Gowatty, *Clark 43243*, 29 Mar 1886 (K); Satte Bhaia Jhai, Darij Serai, *Gamble 2675A*, Jan 1875 (K); Rammagar Hills, *Haines 3983*, Nov 1916 (K); Great Rungeet Valley, Sikkim, *Hooker s.n.*, 1848 (K); Khasia, *Hooker & Thompson*, 16 Jul 1850 (K); Laki, Lakhei County, Lushai Hills, Assam, *Parry 100*, Feb 1927 (K); Koongi Valley, Manipur, *Watt 6796*, 27 Apr 1882 (K). **MYANMAR:** Shan States, *Aplin s.n.*, Nov–Dec 1887 (K); Mundat, *Kingdon Ward 22308*, 18 May 1956 (K); Rangoon, *Meebold 8166*, Jan 1908 (K). **NEPAL:** Mechizou Jhapa district, *Nicolson 3078*, 31 Mar 1967 (BM); Ganjbari (26°45'N 87° 58'E), *Stainton 5733*, 1 Apr 1967 (BM); Udaipur Ganhi (26°56'N 86°31'E), *Stainton 6638*, 3 Nov 1969 (BM). **THAILAND: Chaiyaphum**: near Chulaphorn Dam, *Larsen, Supee, Larsen, Nielsen & Santisuk 31432*, 5 Aug 1972 (BKF). **Chiang Mai**: Doi Pha Hom Pok, Fang, *Kerr 5218*, 3 Apr 1921 (BM, K). **Kanchanaburi:** Ban Huay Sue, E of Thong Pha Phum, *Hill 4645*, 02 May 1994 (NSW, BKF, K, L, PE). **Loei:** Phu Paek, *van Beusekom & Phengklai 3027*, 14 Jan 1970 (L ex BKF). **Mae Hong Son**: Ban Mok Jum Prak, *Hill 4638*, 26 Apr 1994 (NSW). **Phetchabun:** N of Chai Badun, *Abbe, Abbe & Smitinand 9361 B*, 2 Jan 1960 (BKF). **Phrae**: Mae Kating, *Williams & Smitinand 17133* (BKF). **Sukhothai**: Khao Luang, *Kerr 5944*, 4 May 1922 (BM, K). **VIETNAM: Gia Lai:** Tu An, Tu Thuy, between An Khe and Kbang, 30 Oct 1994, *Yang 531, Bau & Lindstrom* (HN); Kbang, 30 Oct 1994, *Yang 532, Bau & Lindstrom* (HN). **Kon Tum:** between Dak Poko and Dak Mek rivers, 1000 m alt, 28 Mar 1995, *US Nat. Geog. Soc. Exped. VH 962, 963* (HN); Dak Poko River near Dak Gley township, 600 m alt, 29 Mar 1995, *US Nat. Geog. Soc. Exped. VH 1017, 1018* (HN); along Dak Poko River 6 km N of Dak Gley township, 6–700 m alt, 16 Apr 1995, *US Nat. Geog. Soc. Exped. VH 1385–1387* (HN), 28 Nov 1995, *VH 2078* (HN), 29 Nov 1995, *VH 2145–6* (HN). **Lam Dong:** Dalat, 5 Nov 1994, *Yang 542, 543, Bau & Lindstrom* (HN). **Quang Ngai:** Duc Pho, Pho Khanh, 25 Jan 2000, *Hiep 4162, 4163, 4164 & Hill* (HN, NSW).

22. ***Cycas hongheensis*** S.Y.Yang & S.L.Yang, in D.Y.Wang, Cycads China: 62 (1996).

Type: Yunnan, Gejiu, *S.Y. Yang 9301*, 17 May 1993 (holo Panzhihua Inst. Hort.; iso FTG, HWA, PE).

Literature: Walters & Yang (1994), Yang & Pu (1994), Yang & Yang (1994)

Illustrations: Yang & Yang (1994), Wang (1996).

Etymology: from Hong-he (the Red River), near the habitat in south-eastern Yunnan, with the Latin suffix *-ensis*, place of origin.

Vernacular: Chinese - *ba-he su-tie*, *hong-he su-tie* (Walters & Yang 1994, Bonta & Osborne 2007).

Stems arborescent, to 1–3 m tall, 12–15 cm diam. at narrowest point; 12–25 leaves in crown. *Leaves* grey-green, dull, 70–100 cm long, strongly to moderately keeled (opposing leaflets inserted at 80–120° on rachis), with 120–140 leaflets, with white tomentum persistent above and below; rachis usually terminated by a spine 5 mm long; petiole c. 26 cm long (30% of total leaf), petiole pubescent, spinescent for 100% of length; basal leaflets not gradually reducing to spines, 95 mm long; spines 1–3 mm long. *Median leaflets* simple, strongly discolorous, 150–200 mm long, 7–8 mm wide, inserted at 50° to rachis, decurrent for 4 mm, narrowed to 4.5 mm at base (to 60% of maximum width), 10 mm apart on rachis; section slightly keeled; margins slightly recurved to recurved; apex acute, not spinescent; midrib flat above or raised above (slightly), raised below. *Cataphylls* narrowly triangular, pungent, thinly sericeous or lacking tomentum, 35–50 mm long. *Cones* not seen.

Historical notes: this member of the *C. pectinata* group was first discovered and noted as a distinct taxon by Chinese botanists in 1993 (Wang 1996), although no reproductive

material was seen. It was finally described in 1996, still in the absence of reproductive material, although seeds were reported by local people to be large.

Distinguishing features: the tall, smooth trunk is quite similar to that of *C. pectinata* and related species from Thailand. The keeled leaves with a moderately persistent white tomentum distinguish it immediately from all other species in the *C. pectinata* group.

Distribution and habitat: known only from a limited area along the Hong He River in Gejiu County (Fig. 6). Once locally common in dense scrub on steep limestone outcrops at lower elevations, but now severely depleted by collecting for sale as an ornamental plant. Plants are in low open vine thickets, often with succulent *Euphorbia* species, and most often rooted in clefts and crevices, often with little no soil at the roots. This species is apparently endemic to these seasonally dry limestone outcrops.

Conservation status: 1997 IUCN Red List of Threatened Plants (Water & Gillett 1998) category E. Ver 3.1:IUCN (2001) status is **CR** (Donaldson 2003).

Selected specimens examined: CHINA: Yunnan: Baohe town, Gejiu county, in dry side valley to north off Hong He valley, on limestone, heavily cut and damaged, *Chen, Jiang, Hill & Stevenson 018*, 8 Jul 2000 (PE, NSW, NY, YAF).

Excluded names

Cycas longipetiolula D.Y. Wang, Cycads China: 68 (1996). Type: China, Yunnan, Yuanjiang River valley, *D.Y. Wang & H. Peng 5523*, 23 Apr 1994 (holo SZG, iso NF). *Cycas multipinnata* is apparently sympatric with *C. bifida* in several populations in China, and a range of morphologically intermediate forms that can be interpreted as a hybrid swarm has been observed. The type of *C. longipetiolula* is one such form.

Cycas multifroudis D.Y. Wang, Cycads China: 80 (1996). Type: cultivated in Xiamen Botanical Garden, *D.Y. Wang 5024*, 28 Jun 1994 (holo SZG, iso NF).). *Cycas dolichophylla* is apparently sympatric with *C. bifida* in several populations in China, and a range of morphologically intermediate forms that can be interpreted as a hybrid swarm has been observed. The type of *C. multifrondis* is one such form.

Acknowledgments

The Slade Foundation of Sydney is gratefully thanked for assistance with travel and field studies. The staff of the Royal Botanic Gardens, Sydney, have been of invaluable assistance, and this would not have been published without them, Leonie Stanberg in particular. Peter Wilson is also thanked for helpful comments on the manuscript. Dr C.J. Chen formerly of the Academica Sinicia in Beijing, assisted greatly in facilitating field studies in China. Forestry Department officers in Guangxi and Yunnan counties ably assisted with fieldwork. Stan Walkley and Dennis Stevenson also provided assistance with field studies.

References

Anon. (1830) *Botanical Magazine* 57: t. 2963, 2964.

Bonta M & Osborne R (2007) Cycads in the Vernacular in *Proceedings of the Seventh International Conference on Cycad Biology. Memoirs of New York Botanical Garden Vol. 97* (in press).

Carruthers W (1893) On *Cycas taiwaniana* sp. nov. and *C. seemanii* A.Br. *Journal of Botany* 31: 1–3, t. 330, 331.

Chen CJ & Liu N (2004) New discoveries of cycads and advancement of conseration of cycads in China. The Botanical Review 70(1): 93–100.

Chen CJ & Stevenson DW (1999) Cycadaceae. Pp. 1–7, in Wu ZY & Raven PH (eds) *Flora of China*, vol 4. (Science Press: Beijing & Missouri Botanical Garden Press: St Louis)

Cheng WC, Fu LK & Cheng CY (1975) Gymnospermae Sinicae. *Acta Phytotaxonomica Sinica* 13(4): 81–82.

Cheng WC & Fu LK (1978) (eds) *Flora Republicae Popularis Sinicae*, vol. 7. *Gymnospermae*. (Academia Sinica: Beijing)

De Candolle AP (1868) Cycadeae. Pp. 361–521 in *Prodromus systema natura and regnum vegetabile*, vol. 16(2). (Victor Massen: Paris)

De Laubenfels DJ & Adema F (1998) Revision of the genera *Cycas* and *Epicycas* gen.nov. (Cycadaceae). *Blumea* 43(2): 351–400.

Donaldson, J S (ed.) (2003) Cycads. Status Survey and Conservation Action Plan. IUCN/SSC Cycad Specialist Group (IUCN: Gland and Cambridge)

Fu GA (2006) A new species of *Cycas* (Cycadaceae) from Hainan Island. *Bulletin Botanical Research* 26(1): 2–3

Gaudichaud-Beaupre C (1829) Botanique. Pp. 432–441 in de Freycinet L *Voyage autour du monde. S.M. Uranie.* (Pillet: Paris)

Grierson AJC & Long DG (1983) *Flora of Bhutan*, vol. 1. (Royal Botanic Gardens Edinburgh: London)

Griffith W (1854) Cycadaceae. *Notulae Ad Plantas Asiaticas* 4: 1–17.

Guan CT & Zhou LJ (1983) Cycadaceae. Pp. 4–12 in Guan CT (ed.) *Flora Sichuanica*, vol. 2. *Gymnospermae*. (Academia Sinica: China)

Hiệp NT & Vidal JE (1996) Cycadaceae. Pp. 6–23 in Morat Ph (ed.) *Flore du Cambodge, du Laos et du Viêtnam*, vol. 28. *Gymnospermae*. (Museum National D'Histoire Naturelle: Paris)

Hill KD (1992) A preliminary account of *Cycas* (Cycadaceae) in Queensland. *Telopea* 5(1): 177–206.

Hill KD (1994) The *Cycas rumphii* complex (Cycadaceae) in New Guinea and Western Pacific. *Australian Systematic Botany* 7: 543–567.

Hill KD (1995) Infrageneric relationships, phylogeny and biogeography of the genus *Cycas* (Cycadaceae). Pp 139–162 in Vorster P (ed.) *CYCAD 93, The 3rd International Conference on Cycad Biology, Proceedings*. (Cycad Society of South Africa: Stellenbosch)

Hill KD (1996) A taxonomic revision of the genus Cycas (Cycadaceae) in Australia. *Telopea* 7: 1–64.

Hill KD (1998) The Cycad Pages, Royal Botanic Gardens Sydney. http://plantnet.rbgsyd.nsw.gov.au/PlantNet/cycad/index.html

Hill KD & Yang SL (1999) The genus *Cycas* (Cycadaceae) in Thailand. *Brittonia* 51: 48–73.

Hill KD, Nguyen HT & Phan LK (2004) The genus *Cycas* (Cycadaceae) in Vietnam. *The Botanical Review* 70(2): 134–193.

Hill KD (2004a) Character evolution, species recognition and classification concepts in the Cycadaceae. Pp. 23–44 in Walters T & Osborne R (eds) *Cycad classification concepts and recommendations*. (CABI Publishing: Wallingford)

Hill KD (2004b) An analysis of morphological characters used in classification of the Cycadaceae. Pp 6–29 in Lindstrom AJ (ed.) *The Biology, Structure & Systematics of the Cycadales Proceedings of the Sixth International Conference on Cycad Biology, Thailand, 29 July–3 Aug, 2002*. (The Nong Nooch Tropical Botanical *Garden*: Sattahip)

Ho P-H (1991) *Cay-co Viet-nam: an illustrated flora of Vietnam*. (P-H Ho: Montreal)

Ho P & Duong N (1960) *Cay-co mien nam Viet-nam*. (Ministry of National Education: Saigon)

Huang YY (2001) *Systematics and Evolution of Cycadaceae in China*. (Meterology Press: Bejing).

IUCN (2001). *IUCN Red List Categories and Criteria : Version 3.1*. (IUCN Species Survival Commission. IUCN: Gland & Cambridge)

Jarvis CE, Barrie FR, Allan DM & Reveal JL (1993) A list of Linnaean generic names and their types. *Regnum Vegetabile* 127: 1–100.

Jones DL (1993) *Cycads of the World*. (Reed: Chatswood)

Kaempfer E (1712) *Amoenitatum exoticarum politico-physico-medicarum fasciculi* (Meyer: Lemgoviae)

Lan KM & Zou RF (1983) A new species of *Cycas* Linn. from Guizhou Province. *Acta Phytotaxonomica Sinica* 21(2): 209–210.

Leandri J (1931) Cycadaceae. Pp. 1085–1092 in Lecomte MH & Gagnepain F (eds) *Flore Generale de L'Indo-Chine*, vol. 5. (Masson et Cie: Paris)

Li H (1980) *Flora of Taiwan*, vol. 1, 2nd edition. (Epoch: Taiwan)

Lindstrom AJ & Hill KD (2007) The genus *Cycas* (Cycadaceae) in India. *Telopea* 11(4): 463–488.

Lindstrom AL, Hill KD & Stanberg LC (2008) The genus Cycas (Cycadaceae) in The Philippines. Telopea 12(1): 119–145.

Linnaeus C (1753) *Species Plantarum*, vol. 1, 1960 facsimile edition. (Engelmann: Weinheim)

Linnaeus C (1754) *Genera Plantarum*, 5th edition, 1934 facsimile edition. (Shokobutu Bunken: Tokyo)

McNeill J, Barrie FR, Burdet H-M, Demoulin V, Hawksworth DL, Marhold K, Nicholson DH, Prado J, Silva PC, Skog JE, Wiersema JH & Turland NJ (2006) *International Code of Botanical Nomenclature (Vienna), adopted by the Seventeenth International Botanical Congress, Vienna ,Austria, July 2005. Regnum Vegetabile 146*. (Gantner: Ruggell)

Merrill ED (1912) *A flora of Manila*. (Bureau of Science: Manila)

Merrill ED (1917) *An interpretation of Rumphius's Herbarium Amboinense*. (Bureau of Science: Manila)

Merrill ED (1923) *An enumeration of Philippine flowering plants*. (Bureau of Science: Manila)

Metcalf FP (1942) *Flora of Fukien*. (Lingnan University: Canton)

Miquel FAW (1842) *Monographia cycadearum*. (Rhenum: Utrecht)

Miquel FAW (1851) *Analecta Botanica Indica*. (Sulpke: Amsterdam)

Miquel FAW (1868) Nouveaux matériaux pour servir à la connaissance des Cycadées. *Archives Néerlandaises des Sciences Exactes et Naturelles* 3(5): 193–254, 403–427.

Osborne R & Tomiyama H (1995) Focus on ... *Cycas revoluta* Thunberg. *Encephalartos* 41: 5–15.

Raizada MB & Sahni KC (1960) Living Indian gymnosperms part 1: Cycadales, Ginkgales and Coniferales. Indian Forestry Records: Botany. (n.s). Bot. 5. (1–4): 73–150.

Rumphius GE (1741) Pp. 86–91 in *Herbarium Amboinensis*, vol. 1 (Burmann: Amsterdam)

Schuster J (1932) Cycadaceae. Pp. 1–168 in Engler A (ed.) *Das Pflanzenreich*, vol. 99(4,1). (Engelmann: Leipzig)

Smith JE (1801) Description of the fruit of Cycas revoluta . *Transactions of the Linneacn Society, London* 6: 312–315, t. 29, 30.

Smitinand T (1971) The genus *Cycas* Linn. (Cycadaceae) in Thailand. *Natural History Bullctin of the Siam Society* 14 (1–2): 163–175.

Smitinand T (1972) Cycadaceae. Pp. 185–192 in Smitinand T & Larsen K (eds) *Flora of Thailand*, vol. 2(2). (Applied Scientific Corporation of Thailand: Bangkok)

Sykes WR (1991) Gymnospermae of Guanxi, South China. *Guihaia*. 11(4): 339–377.

Tang WT, Yang SL & Vatcharakorn P (1997) *Cycads in Thailand*. (Nong Nooch Garden: Chonburi)

Thiselton-Dyer WT (1888) Cycadaceae. Pp. 655–658 in Hooker WJ *Flora of British India*, vol. 5. (Reeve: London)

Thiselton-Dyer WT (1902) Cycadaceae. Pp. 559–561 in Forbes FB & Hemsey WB An enumeration of the plants of China. *Journal of the Linneaen Society, Botany* 26.

Thiselton-Dyer WT (1905). *Cycas micholitzii*. *Gardeners Chronicle serics 3*. 38(973): 142–144.

Thunberg CP (1782) Beschryving van twee nieuwe soorten van Palmboomachtige gewassen, uit Japan en van de Kaap der Goede Hope met eenige Aanmerkingen omtrent de bloemen van de Varens en dergelyke planten. Pp. 419–434 in van Walre (ed.) *Verhandelingen uitgegeeven door de hollandsche maatschappye der weetenschappen, te Haarlem*, part 20(2).

Thunberg CP (1784) *Flora Japonica.* (Mülleriano: Lipsiae)

Walker EH (1976) *Flora of Okinawa and the southern Ryuku Islands.* (Smithsonian Institution: Washington)

Walter KS & Gillett HJ 1997 (1998) [eds] *IUCN Red List of Threatened Plants. Compiled by the World Conservation Monitoring Centre.* (IUCN - The World Conservation Union: Gland & Cambridge)

Walters T & Yang SL (1994) The cycads of China – findings from the Montgomery Foundation / Fairchild Tropical Garden 1992 Expedition, in Tang W (ed.) The Cycads of China. *Journal of the Cycad Society* 1: 6–11.

Walters TW, Yang SL, Pu H & Decker-Walters DS (1995) Cycads of China: observations from a 1992 expedition. Pp 163–175 in Vorster P (ed.) *Proceedings of the third international conference on Cycad Biology (Pretoria, South Africa, July 1993).* (Cycad Society of South Africa: Pretoria)

Wang DY (1996) Systematic classification and taxonomy. Pp. 9–142 in Wang F-X & Liang H-B (eds) *Cycads in China.* (Guangdong Science and Technology Press: Guangdong)

Warburg O (1900) Cycadaceae. Pp. 178–181 in Warburg O (ed.) *Monsunia.* (Engelmann: Leipzig)

Wei FN (1994) A new cycad from Guangxi. *Guihaia* 14: 300.

Xiao LQ, Ge XJ, Gong X, Hao G & Zheng SX (2004) ISSR variation in the endemic and endangered plant *Cycas guizhouensis* (Cycadaceae). *Annals of botany (London)* 94(1): 133–8.

Xiao LQ & Gong X (2006) Genetic differentiation and relationships of populations in the *Cycas balansae* complex (Cycadaceae) and its conservation implications. *Annals of Botany* 97(5): 807–812.

Yang SL & Pu, H (1994) 1993 Expedition in China, in Tang W (ed.) The Cycads of China. *Journal of the Cycad Society* 1: 12–19.

Yang SL & Yang SY (1994) A Note on the Cycads in Yunnan, South-Western China. *Encephalartos* 40: 10–13

Zamora PM & Co L (1986) *Guide to Philippine flora and fauna*, vol. 2. *Descriptions of Gymnosperm species.* (Ministry of Natural Resources & University of the Philippines: Quezon City)

Zhou L Yang SY & Zhou Z (1990) Investigation of the natural community of *Cycas panzihuaensis* L.Zhou & S.Y.Yang. *Memoirs of the New York Botanical Gardens* 57: 148–151.

Manuscript received 16 August 2006, accepted 22 November 2007